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FINDING, MANAGING, AND STUDYING PREHISTORIC CULTURAL RESOURCES AT EL DORADO LAKE, KANSAS (PHASE I)

Edited by
Gary R. Leaf

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University of Kansas
Museum of Anthropology
Research Series

Number 2

EDITORIAL NOTE

Although we had hoped, during the period following the 1974 publication of Number 1 of this series and the present, to bring forth several additional numbers, the availability of funding for the results of Anthropological research remains limited. Consequently, we are pleased that with the publication of the present monograph, Number 2, we are able to resume publication of the Research Series. Two additional numbers are in preparation, while a third is on the horizon. We are at least sufficiently encouraged by this development and sufficiently confident in the future, to repeat a sentence from our earlier editorial note, "Subsequent issues of the Series, incorporating papers and monographs from the various sub-disciplines of Anthropology, will appear on an irregular basis."

In the meantime, Number 1 of the Research Series, "Kansas City Hopewell Activities at the Diester Site," by Susanna R. Katz is available from the Museum of Anthropology at the University of Kansas for $2.00.

Alfred E. Johnson
Anta Montet-White
Editors

LEVEL II

(12)

University of Kansas

Museum of Anthropology

Research Series

Number 2

FINDING, MANAGING, AND STUDYING PREHISTORIC CULTURAL RESOURCES AT EL DORADO LAKE, KANSAS (PHASE I)

Edited by Gary R. Leaf

Contributors:

Darrell Drew
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Prepared for:

Department of the Army
Corps of Engineers
Tulsa District

Accomplished under the Terms of Contract Number DACW56-77-C-0221

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ABSTRACT

The general problem orientation for archeological investigations at El Dorado Lake can be characterized as ecological. The goals are to retrieve data and test hypotheses on: (1) the synchronic and diachronic interrelations among prehistoric subsistence and settlement systems and (2) the environmental conditions to which those systems were adapted. In order to accomplish the research objectives, it is proposed: (1) that all impacted archeological sites in the project be mapped, surface collected, and tested; (2) that block excavations be placed on components representing each cultural affiliation, time period, and settlement function; and (3) that environmental analyses be conducted by an interdisciplinary research team.

The archaeological site reconnaissance was completed in 1977. Upland prairie regions and localities with low site density in creek and river valleys were surveyed; two new upland and thirteen new valley sites were recorded. A total of sixty-six prehistoric sites are located in the project area; they represent Archaic, Woodland, and Plains Village occupations. The extant inventory of prehistoric sites is not exhaustive of all those which are, or were at one time, present. Survey data biases affect the observed pattern of site location and preclude discovery of all sites once present. These biases are discussed and recommendations to minimize their effects on future analyses are made.

Archeological sites not threatened by total inundation will be subjected to various other destructive agencies; these include shoreline erosion; soil, sediment, and chemical alterations due to periodic flooding; and increased vandalism. Although the harmful effects of lake construction will be partially mitigated by test and/or full-scale excavation, remaining cultural deposits should be protected. Specific management recommendations are given for sites not affected by flooding or construction. Other sites must await testing for final management recommendations.

Five prehistoric sites were tested during the 1977 field season. 14BU31 is a single component Woodland base camp. The site contains a small area of intact occupation zone from which was recovered two limestone filled roasting pits and an artifact assemblage compatible with hunting and gathering subsistence activities. 14BU57 also contains an intact cultural midden. The artifact classes, inferred activities, probable presence of one or more houses, and internal site structure suggest that 14BU57 is a hamlet or small village. The single component may represent the transition of Late Woodland into Plains Village in south-central Kansas. The third site, 14BU82, has Archaic, Woodland, and Plains Village components mixed together in the plowzone. It may be a hunting camp, but the inference is difficult to substantiate because the site has been destroyed by cultivation. 14BU30 was also destroyed by cultivation; it contains Woodland and Plains Village components. The fifth site, 14BU27, has a partially buried Woodland component and may also be a small village or hamlet. All five sites exhibit lithic raw material variability suggestive of participation in regional exchange networks. Two sites, 14BU57 and 14BU27, are assigned

a high priority status with respect to future salvage excavation.

A preliminary geographical and paleogeographical study of the El Dorado Lake area establishes the research goals of developing models of present and past environments that can be related to the area's human occupation. Since relatively little is known about the region's paleoenvironments, formulation of a paleogeographic model will take precedence. A literature search provided background information and a number of hypotheses which can guide future studies.

A preliminary field survey was conducted to determine the project area's potential for palynological studies. Three promising sites were examined in the field and sampled for laboratory analysis. None of the sampling stations contained an extensive pollen record. A sufficient number of pollen studies are available from the central United States, however, on which to base an outline of the Late Quaternary vegetational changes expected for south-central Kansas.

In order to examine prehistoric utilization of chert, the raw materials of the region must be delineated and characterized. There are ten chert-bearing stratigraphic members in the project area, each of which forms a distinct topographic feature. Descriptions of locally occurring chert in the geologic literature are too vague and inconsistent to be useful in establishing replicable type descriptions. While the variation within chert formations severely limits the use of physico-chemical methods of characterization, the varying processes of deposition and diagenesis affected morphological features enough that it should be possible to descriptively characterize material from known stratigraphic units. These data can then be applied to chert recovered from archeological sites.

PREFACE

In May of 1977 the United States Army Corps of Engineers, Tulsa District, contracted with the Museum of Anthropology, University of Kansas, to conduct a four phase study of cultural resources at El Dorado Lake, Butler County, Kansas. This monograph is the first of an anticipated series that will provide the Corps with data and information necessary for compliance with the National Historic Preservation Act of 1966 (Public Law 89-655), Executive Order 11593, the Archeological and Historic Preservation Act of 1974 (Public Law 93-291), and other federal laws pertaining to cultural resources in the project area.

The investigations reported in this volume were guided by a research design for impacted archeological sites and the contract's Phase I scope of services. The work to be performed under Phase I of the contract included: (1) the completion of an intensive surface reconnaissance of all federal land in the project and a recheck of areas displaying unexpected low site densities, especially the Walnut River at the upper end of the flood pool, Satchel Creek, and the middle reaches of Durechen Creek; (2) the test excavation of archeological sites located in areas threatened by current or impending construction activities; (3) a laboratory analysis consisting of any procedures and disciplines necessary to prepare a complete, accurate, and useful report; and (4) a report which contains the research design, study results, an inventory of prehistoric cultural resources, and a management plan for cultural resources which will not be impacted by the project.

In accord with the specifications of the contractual agreement, this monograph reports the results of Phase I archeological investigations. Chapter 1 presents a summary of previous archeological research conducted in the project area and formulates a research design that is partially based on those preliminary results. Chapter 2 discusses the completed surface reconnaissance; Chapter 3 offers a management plan for prehistoric cultural resources not threatened by project activities. The results of test excavations conducted during the 1977 field season are discussed in Chapter 4. A preliminary study of the natural environment is presented in Chapter 5. The results of a pilot project designed to determine the feasibility of obtaining a pollen record useful for inferring a regional vegetation and climatic history are discussed in Chapter 6. And, finally, Chapter 7 presents a study of chert-bearing rock formations found in the project area. Where it is appropriate, all of the authors discuss the articulation of their respective chapters with both the research design and scope of services specifications. In addition, they present the details of methods and techniques utilized, background literature and theory, problems encountered, and develop research problems and orientations which may be profitably considered in future studies.

The artifacts and specimens recovered during Phase I investigations, as well as field and laboratory notes, maps, drawings, and photograph negatives, are curated at the Museum of Anthropology, University of Kansas, Lawrence. All storage containers are clearly labelled "Property of the U.S. Government, Army Corps of Engineers, Tulsa District." This report is accompanied by a separate appendix that contains background data and other specifics required by the Corps which are not suitable for public distribution.

ACKNOWLEDGEMENTS

We gratefully acknowledge the financial support, facilities, and equipment provided by the Tulsa District, Corps of Engineers, and the Museum of Anthropology, University of Kansas.

Many individuals contributed effort toward the completion of this report. The field crew (Pat Miller, Chérie Haury, Matthew Root, Ricky Roberts, Roger Williams, Dayton Bard, Alan Nelson, Albert Johnson, Will Malone, Chris Wright, Joe Artz, Stewart Johnson, and Roger Saft) worked seven days a week under unusually wet and poison ivy infested conditions. Thanks goes to the staff at El Dorado Lake, Project Manager's Office, for help and advice. Mr. Glen Brooks, Vice President of the Sherwood Construction Company (Wichita, Kansas) authorized the use of a scraper for large scale dirt moving at 14BU30 and 14BU27. Loretta E. Doemland performed most of the tedious laboratory work. Patricia Renjifo and Deb Bennett drew the artifact illustrations. Kathy Clyde and secretarial assistants in the Department of Anthropology typed the final draft.

Sincere thanks is extended by various chapter authors to those University of Kansas staff and faculty members who patiently advised, guided, and supported their endeavors. Appreciation is expressed to Roger Kaesler, Wakefield Dort, Larry Martin, Joseph Collins, Jesse McNellis, Howard O'Connor, and Robert Hoffman. Larry Banks, Corps of Engineers Division Office, Dallas, made his unpublished manuscript available for study.

Special thanks goes to Alfred E. Johnson, Director of the Museum of Anthropology, who served as principal investigator on this project; thanks also to Susan Purves, Tulsa District Archeologist and Contract Administrator.

The editor thanks the authors of the chapters contained herein for sharing the burden of analysis and writing. Chérie Haury and Matthew Root worked long hours as editorial assistants.

CONTENTS

ABSTRACT ii

PREFACE iv

ACKNOWLEDGEMENTS vi

LIST OF FIGURES ix

LIST OF TABLES xii

CHAPTER 1. A RESEARCH DESIGN FOR IMPACTED ARCHEOLOGICAL SITES AT EL DORADO LAKE, BUTLER COUNTY, KANSAS (Gary R. Leaf) 1

- Introduction 1
- El Dorado Lake: Physical Setting 1
- Previous Research and Results 5
- Orientations for Future Research 15
- Reconnaissance 16
- Test Excavations 21
- Salvage Excavations 24
- Environmental Studies 27
- Concluding Remarks 30

CHAPTER 2. ARCHEOLOGICAL SITE SURVEY IN THE EL DORADO LAKE AREA, SOUTH-CENTRAL, KANSAS (Matthew J. Root) 31

- Introduction 31
- Survey Techniques 32
- Survey Results 34
- Summary and Conclusions 57

CHAPTER 3. A MANAGEMENT PLAN FOR THE PREHISTORIC CULTURAL RESOURCES OF EL DORADO LAKE (Matthew J. Root) 61

- Introduction 61
- Impacts on Cultural Resources 61
- Cultural Resource Management Recommendations 66
- Summary 73

CHAPTER 4. TEST EXCAVATIONS CONDUCTED AT EL DORADO LAKE, 1977 (Gary R. Leaf) 74

- Introduction 74
- 14BU31 78
- 14BU57 112
- 14BU82 141
- 14BU30 158
- 14BU27 173

CHAPTER 5. LATE QUATERNARY HISTORY AND PALEOGEOGRAPHY OF THE EL DORADO LAKE AREA, KANSAS (Darrell Drew) 188

Introduction 188
Research Methods and Results 190
Projected Future Research 199
Hypothesis Testing and Experimental Studies 201

CHAPTER 6. PRELIMINARY SURVEY FOR PALYNOLOGICAL SITES IN THE EL DORADO LAKE AREA, KANSAS (James E. King) 203

Introduction 203
Field Survey 203
Laboratory Procedures 206
Discussion 206
An Outline of Late Quaternary Vegetation Change for South-Central Kansas 207

CHAPTER 7. CHARACTERIZATION OF THE CHERT RESOURCES OF EL DORADO PROJECT AREA (Chérie E. Haury) 209

Introduction 209
The Geology of the Research Area 210
Macroscopic Characteristics of Local Cherts 217
Characterization 220
Implications for Further Research 226

REFERENCES CITED 228

LIST OF FIGURES

1.1 El Dorado Lake is located on the Walnut River which drains the western slope of the Flint Hills in Butler County, Kansas. 2

1.2 Topographic cross section and ecological resource zone model of the El Dorado locality. 4

1.3 The location of archeological sites recorded at El Dorado Lake as of 1976. 6

2.1 Location of find spots in the El Dorado Lake area. 35

2.2 Location of archeological sites in the El Dorado Lake area. 40

2.3 Chipped stone artifacts from the El Dorado Lake area. . . . 42

2.4 Projectile points from the El Dorado Lake area. 49

2.5 Chipped stone artifacts from the El Dorado Lake area. . . . 52

4.1 Borrow excavation for dam fill has destroyed 14BU3. 75

4.2 El Dorado project area showing the location of archeological sites tested in 1977. 76

4.3 Contour map of 14BU31 showing the location of test excavations and limits of surface debris. 79

4.4 Plan view of XU101 (14BU31). 81

4.5 West wall profile from XU101 (14BU31). 81

4.6 Distribution of plotted artifacts in XU102, level 2 (20-30 cm.) (14BU31). 83

4.7 Distribution of plotted artifacts in XU102, level 3 (30-40 cm.) (14BU31). 83

4.8 Plan view of partially excavated feature 302, XU102 (14BU31). 84

4.9 Profiles of backhoe trenches 1 and 3 showing the location of features and naturally deposited scatters of burned earth and charcoal (14BU31). 86

4.10 Chipped stone cores (14BU31). 97

4.11 A discoidal core from 14BU31. 98

4.12 Chipped stone tools (14BU31). 106

4.13 Bifaces from 14BU31. 107

4.14 Bifacially retouched tools (14BU31). 109

4.15 Contour map of 14BU57 showing the location of test excavations, posthole tests, and limits of surface debris. . . . 113

4.16 Horizontal distribution of plotted artifacts in XU101 (14BU57): (a) level 3, (b) level 4. 116

4.17 West wall profile from XU101 (14BU57). 117

4.18 Horizontal distribution of plotted artifacts in XU102 (14BU57): (a) level 2, (b) level 3. 119

4.19 Chipped stone artifacts from 14BU57. 132

4.20 Contour map of 14BU82 showing the location of test excavations, limits of surface debris, and internal areas of high artifact concentration. 142

4.21 West wall profile from XU101 (14BU82). 145

4.22 Chipped stone tools (14BU82). 154

4.23 Large bifaces from 14BU82. 156

4.24 Contour map of 14BU30 showing the location of test excavations and earth mover scrapes. 159

4.25 Earth mover cutting scrape number 2 (14BU30). 160

4.26 East wall profile from XU101 (14BU30). 161

4.27 Sandstone mano, 14BU30. 163

4.28 Chert tools from 14BU30. 170

4.29 Contour map of 14BU27 showing the location of earth mover scrape and test excavations. 174

4.30 Feature 303 plan and profile, XU103 (14BU27). 177

4.31 West wall profile from XU101 (14BU27). 178

4.32 Chipped stone tools from 14BU27. 185

6.1 The location of soil sampling stations for the feasibility study of pollen extraction. 205

7.1 A portion of the U.S.G.S. Geologic Map of Kansas (1964) illustrating exposed rock units in the research area. . . . 211

7.2 Stratigraphic section of the Gearyan Stage. 212

7.3 Stratigraphic section of the Virgilian Stage. 215

7.4 Stratigraphic section of the Cimarronian Stage. 216

LIST OF TABLES

1.1 Radiocarbon dates from archeological sites at El Dorado Lake. 10

1.2 Initial level of investigation recommended under the research design for archeological sites recorded at El Dorado Lake as of 1976. 17

2.1 Ground surface visibility scale. 32

3.1 Summary of impacts on the prehistoric cultural resources of El Dorado Lake. 62

3.2 Approximate straight line distance of archeological sites which are above multipurpose pool elevation from project features. 68

4.1 Depth distribution of artifacts recovered in XU101 (14BU31). 82

4.2 Depth distribution of artifacts recovered in XU102 (14BU31). 82

4.3 Limestone counts, weights, and distribution (14BU31). 89

4.4 Water flotation recovery from excavation levels in XU102 and three features (14BU31). 91

4.5 Pottery temper distribution (14BU31). 92

4.6 Quartzite artifact dimensions and weights (14BU31). 93

4.7 Selected raw materials (14BU31). 94

4.8 Chipped stone artifact distribution (14BU31). 95

4.9 Cores and core fragments (14BU31). 96

4.10 Chunks and shatter (14BU31). 100

4.11 Complete flakes (14BU31). 101

4.12 Proximal flake fragments (14BU31). 102

4.13 Other flake fragments (14BU31). 103

4.14 Chipped stone tools (14BU31). 104

4.15 Depth distribution of artifacts recovered in XU101 (14BU57). 114

4.16 Depth distribution of artifacts recovered in XU102 (14BU57). 117

4.17 Distribution of burned earth, daub, and pottery (14BU57). . 120

4.18 The occurrence of pottery temper in relation to context of recovery (14BU57). 121

4.19 Limestone counts, weights, and distribution (14BU57). . . . 123

4.20 Counts, weights, and distribution of excavated bone (14BU57). 124

4.21 Identified skeletal elements and their context of recovery (14BU57). 126

4.22 Chipped stone artifact distribution (14BU57). 128

4.23 Cores and core fragments (14BU57). 129

4.24 Chunks and shatter (14BU57). 129

4.25 Complete flakes (14BU57). 131

4.26 Proximal flake fragments (14BU57). 133

4.27 Other flake fragments (14BU57). 133

4.28 Distribution of potlid chert types (14BU57). 134

4.29 Distribution of thermally altered chert (14BU57). 135

4.30 Chipped stone tools (14BU57). 137

4.31 Depth distribution of artifacts recovered in XU101 (14BU82). 144

4.32 Limestone counts, weights, and distribution (14BU82). . . . 147

4.33 Chipped stone artifact distribution (14BU82). 148

4.34 Selected raw materials (14BU82). 149

4.35 Cores and core fragments (14BU82). 149

4.36 Chunks and shatter (14BU82). 150

4.37 Complete flakes (14BU82). 151

4.38 Proximal flake fragments (14BU82). 152

4.39 Other flake fragments (14BU82). 152

4.40 Chipped stone tools (14BU82). 153
4.41 Limestone counts and weights (14BU30). 162
4.42 Ceramic surface treatment compared with temper (14BU30). . 164
4.43 Chipped stone artifact counts (14BU30). 165
4.44 Cores and core fragments (14BU30). 166
4.45 Chunks and shatter (14BU30). 166
4.46 Complete flakes (14BU30). 167
4.47 Proximal flake fragments (14BU30). 168
4.48 Other flake fragments (14BU30). 168
4.49 Chipped stone tools (14BU30). 169
4.50 Depth distribution of artifacts in XU101 (14BU27). 175
4.51 Depth distribution of artifacts in XU102 (14BU27). 176
4.52 Limestone counts, weights, and distribution (14BU27). . . . 179
4.53 Body sherd surface treatment and temper (14BU27). 181
4.54 Chipped stone artifact distribution (14BU27). 181
4.55 Cores and core fragments (14BU27). 182
4.56 Chunks and shatter (14BU27). 182
4.57 Complete flakes (14BU27). 183
4.58 Proximal flake fragments (14BU27). 183
4.59 Other flake fragments (14BU27). 184
4.60 Chipped stone tools (14BU27). 185
7.1 Summary of local chert types. 221

CHAPTER 1

A RESEARCH DESIGN FOR IMPACTED ARCHEOLOGICAL SITES AT EL DORADO LAKE, BUTLER COUNTY, KANSAS

Gary R. Leaf

INTRODUCTION

A research design and salvage mitigation plan were developed for the National Park Service in 1976 to guide the study of all significant cultural resources (historical, architectural, and archeological) in the El Dorado Lake project, Butler County, Kansas (Leaf 1976a). In May of 1977 the United States Army Corps of Engineers, Tulsa District, contracted with the Museum of Anthropology, University of Kansas, to conduct a multi-phase, four year investigation of the cultural resources at El Dorado Lake. This chapter is a condensed version of the National Park Service report and discusses the research problems and potentials in the project area as they were perceived in 1976. It should be made clear at the outset that the remaining chapters in the present volume contribute studies that were required by Phase I scope of work statements, but which have also been guided by the research design in so far as that was possible.

The principle goals of the research design are: (1) to retrieve data and test hypotheses on prehistoric subsistence and settlement systems; and, (2) to conduct an interdisciplinary program to retrieve data and test models of paleoenvironments useful for the study of prehistoric cultural ecological relationships. Operationally, these enquiries are organized in such a manner so as to maximize the rescue of relevant data from the present to the time of dam closure in 1980.

The following paragraphs present a preliminary description of the project area's physical setting, summarize previous archeological work at El Dorado Lake, and discuss the research design.

EL DORADO LAKE: PHYSICAL SETTING

El Dorado Lake, a United States Army Corps of Engineers project, will be created by a rolled earth dam located approximately 3.2 km. (2 mi.) northeast of the city of El Dorado, Kansas. The dam, currently under construction, will lie across the southward flowing Walnut River (Fig. 1.1). When completed, the lake will inundate some 24 km. (15 mi.) of the Walnut as well as substantial portions of its tributary creeks. The multipurpose pool will cover 3,240 ha. (8,000 a.) of land and at full flood control pool it will inundate 4,050 ha. (10,000 a.) (U.S. Army Corps of Engineers 1972).

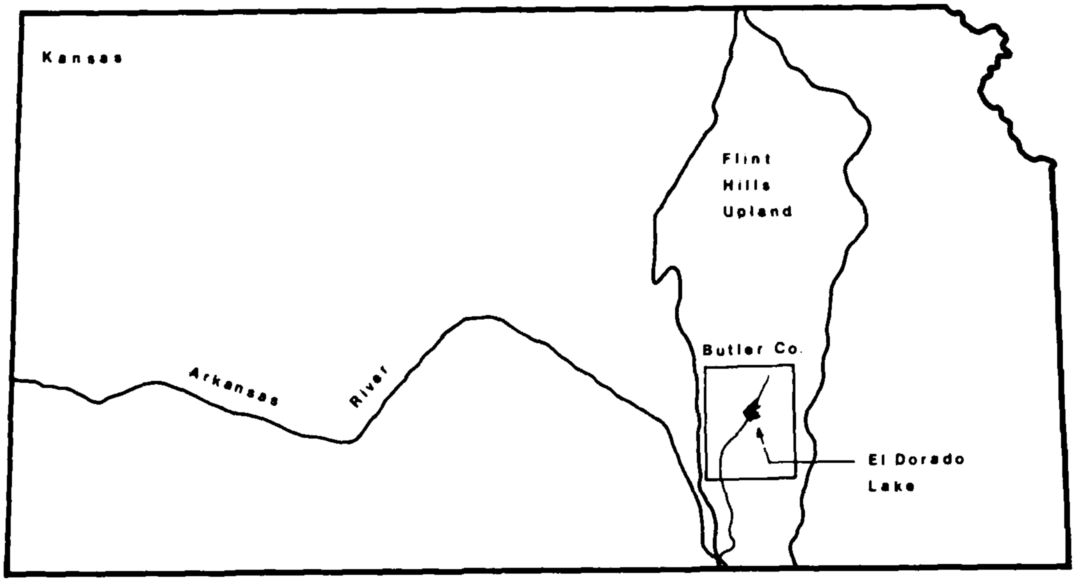

Figure 1.1. El Dorado Lake is located on the Walnut River which drains the western slope of the Flint Hills in Butler County, Kansas.

Physiographically, the state of Kansas lies within the North American Interior Plains. El Dorado Lake is geographically situated on the western slope of the Flint Hills upland division of the Osage Plains section of the Central Lowland province. The Flint Hills are a north-south topographic feature that forms a highly dissected east facing escarpment across east-central Kansas; their limits are defined by outcrops of chert bearing Permian strata of limestone and shale. The Flint Hills in Butler County have never been glaciated; their surface is gently rolling and gradually slopes to the west toward the Arkansas River Valley (Schoewe 1949:280-9).

The major soil associations in the research area can be divided into two types based on their modes of origin: (1) upland soils were formed under prairie grasses growing on the products of Flint Hills erosion; and, (2) soils in the creek and river bottoms were formed from alluvial sediments and modified by floodplain forests (U.S. Army Corps of Engineers 1972; Frye and Leonard 1952; Zeller 1968).

The study area has a continental climatic regime; the weather is highly changeable and exhibits a great deal of diurnal and seasonal variation. The winters are cold and dry, and average about 105 days per year with a minimum temperature below freezing. The mean maximum temperature in January, the coldest month, is 5.5 degrees C. (42 degrees F.); the mean minimum is -5.5 (22 F.). The first killing frost normally occurs in mid-October, the last in mid-April. The average length of the growing season is 184 days. Summers are hot with generally low relative humidity (60% or less). The mean annual precipitation is 79 cm. (31 in.), mostly in the form of thunderstorms during the spring and summer months. Rainfall is most likely to occur in May and June; January is the month of

least precipitation. The Walnut River may flood after a torrential or prolonged rain. The mean maximum temperature in July, the warmest month, is 34 degrees C. (93 F.), the mean minimum is 20 degrees C. (68 F.). The summers average 65 days per year with a maximum temperature above 32 degrees C. (90 F.). March and April are the windiest months in the study area; July and August are the least windy. Air currents are strongest during the warmest hours of the day (afternoons) and fall off at night. The prevailing winds are southerly and have an average velocity of 18.4 km. (11.5 mi.) per hour. The lake area has an annual average of 175 clear and sunshiny days, and about 90 cloudy days. The generally high temperatures, low relative humidity, abundant sunshine, and brisk winds maintain a high rate of moisture loss to evaporation and transpiration during the summer months (Flora 1948; Borchert 1950).

A model of the ecological resource zones (Fig. 1.2) of potential importance for the subsistence economies of prehistoric human groups in the El Dorado Lake area has been posited for the mid 19th century from General Land Office survey notes and plats, and from modern vegetation and faunal studies (Fulmer 1976; U.S. Army Corps of Engineers 1972; Hall 1955; Schwartz and Schwartz 1959; Johnston 1960; Barker 1969). Five probable resource zones are indicated: (1) upland prairie, (2) floodplain forest, (3) breaks, (4) riverine, and (5) oxbow swamp.

The upland prairie is dominated by grasses. Plant species of economic importance to prehistoric man do not represent a large proportion of the prairie biomass, but the situation is markedly different for faunal resources; especially notable are bison, deer, and antelope. Even though the biomass of potential food items in the riverine and oxbow swamp zones, the loci of aquatic plants and animals, is rather low, aquatic resources may have been an important nutritional component of prehistoric diets. The major critical subsistence item in the two zones is, of course, water. The floodplain forest, an oak-hickory association, offered a wide variety of subsistence resources, including nuts, berries, fruits, deer, elk, turkey, and squirrel. This zone also contained raw materials suitable for building shelters, and fuel for cooking and heating. The breaks zone is the steep and eroded slope that joins the upland prairie with the floodplain forest areas. The breaks had little to offer in the form of food items, but may have been the major source of suitable chert from which chipped stone tools were manufactured.

From a regional perspective, the project area is predominantly upland prairie. The floodplain forest and breaks rank second and third, respectively, in total surface area; the riverine and oxbow swamp zones comprise a miniscule portion of the locality. When completed, El Dorado Lake will inundate the floodplain forest, oxbow swamp, and riverine zones; it will flood part of the breaks, but very little upland prairie. The research design must, therefore, be adjusted to compensate for the large proportions of river valley resource zones located in the lake's flood control pool.

The ecological resource zone model is preliminary and tentative in the sense that it is an incomplete list of potential subsistence items; the actual food resources procured by prehistoric human groups must be empirically determined from the archeological record. In addition, there

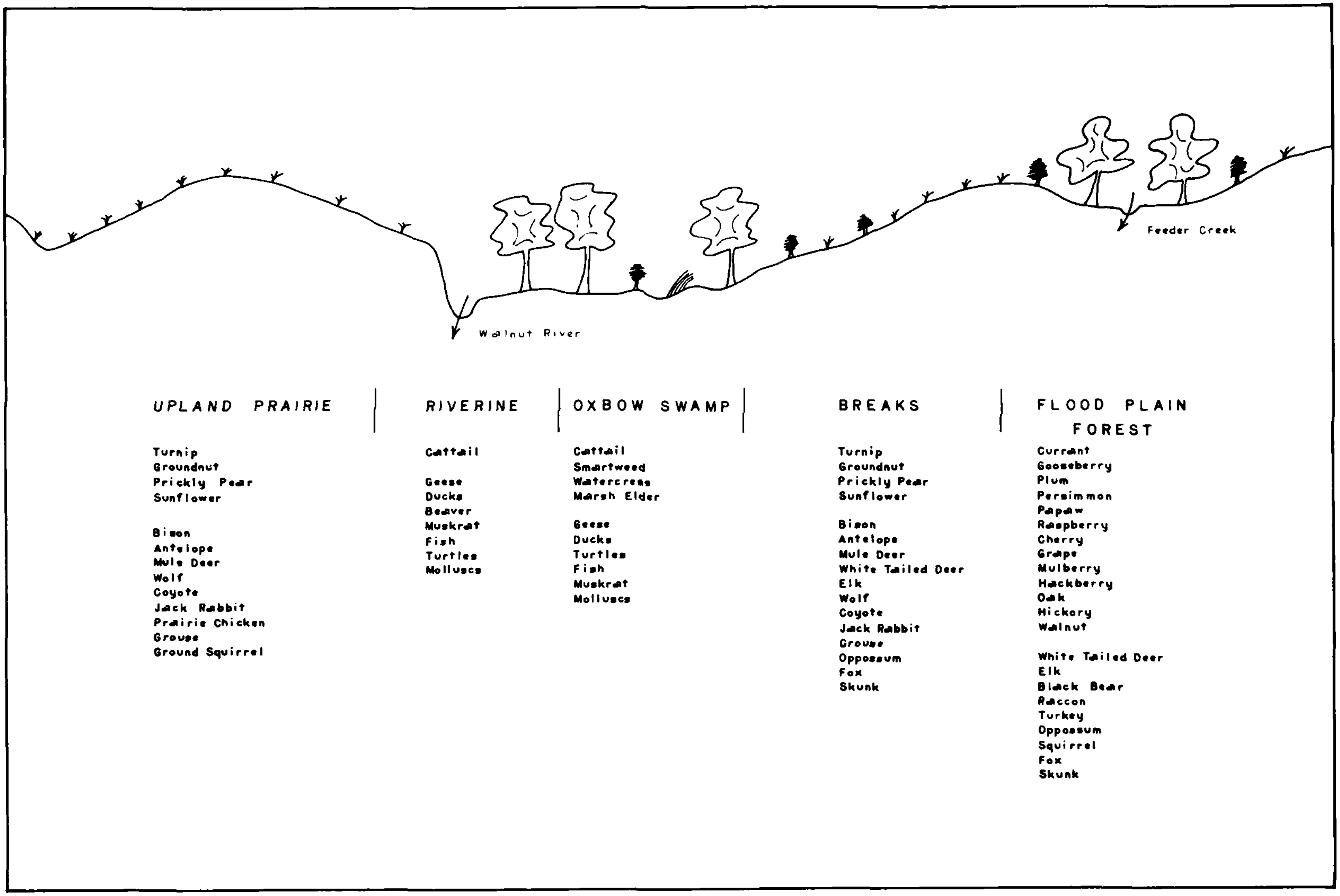

Figure 1.2. Topographic cross section and ecological resource zone model of the El Dorado locality.

are numerous methodological problems with an ecosystem model constructed from historic documents (Bourdo 1956; Wood 1976; F. King 1978); the model diagrammed in Figure 1.2 does not take into account phytogeographical and seasonal variation, the selectivity of subsistence systems, prehistoric man's impact on plant and animal communities, or the ecosystem changes that are known to have occurred in the 12 millenia man may have occupied the region (Dort and Jones 1970). In short, the nature of the ecosystem and its component subsistence resources and culturally important raw materials will be an important focus in the research design offered below.

PREVIOUS RESEARCH AND RESULTS

Archeological remains in the southern Flint Hills of Kansas, and adjacent regions, were noted by several workers prior to authorization of the El Dorado Lake project (Meade 1901, 1905; Moorehead 1931; Wedel 1959). Systematic investigations in the project area were initiated in 1967 and have continued to the present; this work includes archeological reconnaissance (Eoff and Johnson 1968; Barnes and Lubovich 1974; Fulmer 1976, 1977), subsurface tests (Bastian 1978; Fulmer 1977), major excavations (Grosser 1970, 1973, 1977; Bradley 1973; Fulmer 1976), and related analytical studies (Grosser and Klepinger 1970; Klepinger 1972).

As of 1976 the cultural resource inventories had not been completed for this Corps of Engineers project; however, 48 archeological sites were known to exist on federal property (Fig. 1.3). Forty-one of those sites lie within the confines of the lake's flood pool; five other sites are situated on federal property, but only one of them, 14BU70, will be directly impacted by construction. Two additional sites, 14BU72 and 14BU73, lie on federal property, but the nature of flood pool impact, if any, has not been determined. The exact location and distribution of 14BU25 with respect to property boundaries and flood pool impact is also not known. Thus, current figures, based on incomplete inventories, indicate that there will probably be at least 45 archeological sites inundated or destroyed by shoreline erosion and construction. The 45 recorded sites contain a total of 51 distinct prehistoric components; 23 components have undetermined cultural affiliations, but the remaining 28 represent occupations of the Plains Archaic (11), Plains Woodland (15), and Plains Village (2) cultural traditions.

Excavations have been conducted on five Archaic sites: (1) 14BU9, the Snyder site; (2) 14BU50, the Falconer site; (3) 14BU25, the Milbourn site; (4) 14BU4; and (5) 14BU92. Snyder (14BU9) is located near a meander on the west (right) bank of the Walnut River about 1.6 km. upstream from the mouth of Satchel Creek (Fig. 1.3). Prehistoric surface debris covers some 10 ha. on two terraces that are separated from one another by a former channel of the Walnut River. The abandoned channel is approximately 40 m. wide and devoid of artifactual debris. There is a continuously flowing spring 500 m. northwest of Snyder, that, according to local informants, does not dry up during severe droughts. During four field seasons, excavations were conducted by Grosser (1970, 1973, 1977) in an area marked by the heaviest concentrations of surface materials on the western terrace. The 2.5 m. deep excavations have demonstrated the existence of one Woodland component and more than three Archaic components.

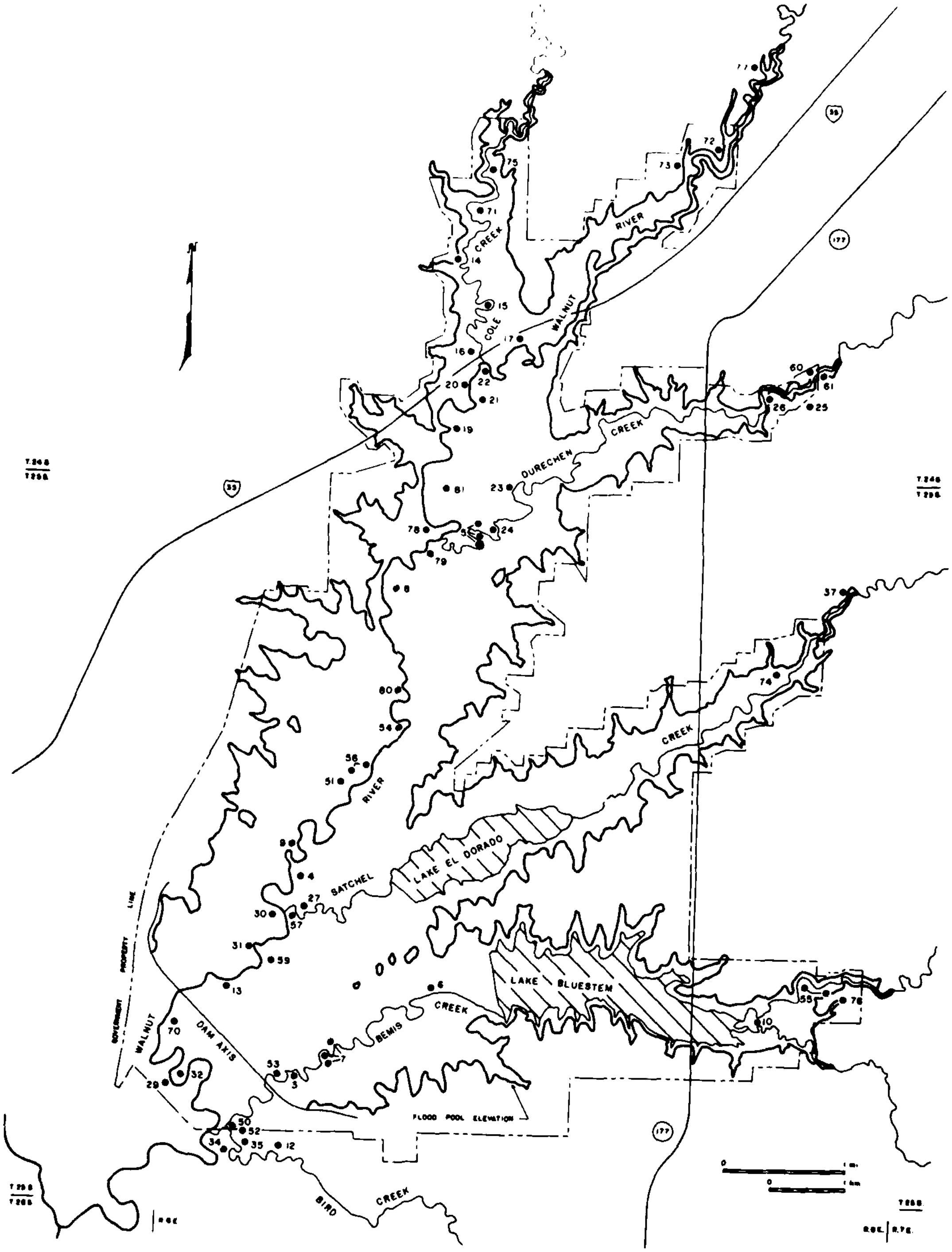

Figure 1.3. The location of archeological sites recorded at El Dorado Lake (shown at full flood control pool) as of 1976. Site numbers are prefaced with the state and county designations "14BU".

The surface component, Butler phase Woodland, estimated at A.D. 200 to 800, was scattered throughout the plowzone. However, portions of 22 Woodland storage pits extended below the plowzone into an underlying yellowish-brown clay. The clay zone was culturally sterile except for the intrusive pits. Recovered ceramics include a numerically predominant calcite tempered ware with cord marked exteriors; a second, but less numerous, type has zoned dentate stamping on the rim exterior and is tempered with fired clay. Projectile points include a variety of small, either notched or unnotched, triangular forms suitable for use with the bow and arrow. There are also some larger forms, either notched or stemmed, that could have been hafted knives or atlatl dart points. Other chipped stone tools include scrapers, celts, bifaces, and retouched and utilized flakes. This lithic assemblage is interpreted as a set of hunting and butchering implements; the predominance of deer and bison in the faunal remains corroborates that inference. There are a number of dolomite and sandstone grinding stones. The presence of grinding stones indicates that floral food resources were also being used.

The sterile yellowish-brown clay horizon stratigraphically separates the overlying Butler phase Woodland component from the late Archaic Walnut phase component, estimated to range from 900 B.C. to A.D. 1. The Walnut phase component is known from a relatively small number (107) of chipped stone tools which were sparsely scattered throughout a sediment zone 40 cm. thick. The most frequent projectile points were small, triangular, corner-notched forms light enough to have been used with a bow and arrow. Larger corner-notched and stemmed forms are thought to have been atlatl dart points. There were also a small number of bifaces, scrapers, and retouched and utilized flakes; chipping debris was abundant. No floral remains or ceramics were recovered. The butchered remains of four deer and three bison were recovered. These fauna, in conjunction with five hearths that were excavated, suggest that the Walnut phase component was a temporary hunting camp where game was processed and chipped stone tools were manufactured and repaired.

Ten centimeters of artifactually sterile soil separates the Walnut phase component from the El Dorado phase component, which is estimated to range from 1900 to 1100 B.C. The projectile points from this component are markedly different from those in the overlying Walnut phase; they are stemmed lanceolates suitable for use as atlatl dart points. Other chipped stone tools include knives, scrapers, choppers, drills, and axes; hammerstones and grinding stones were retrieved as well. The chert tools represent hunting, butchering, hideworking, and woodworking activities; the hammerstones and chipping debris attest to tool manufacture and maintenance activities; and the large number of grinding stones associated with the deposit indicates an extensive use of plant foods. These interpretations are backed up by the presence of hackberry, pigweed, and chenopod floral remains and an impressive list of faunal remains, i.e., deer, bison, rabbit, antelope, beaver, badger, raccoon, muskrat, otter, ferret, coyote, prairie dog, fish, box turtle, and a small number of birds and fresh water mussels. Several features were discovered: 3 hearths, 4 postmolds, 6 storage pits, and 1 burial. Two large dark stains, associated with concentrations of burned earth, daub, scattered limestone, and a number of mud dauber nests, are thought to be the remains of houses. The relationship of the two stains to the postmolds is uncertain. The El Dorado phase component is interpreted as a possible base camp or village.

The third Archaic component, representing the Chelsea phase, whose estimated time span is 2700 to 2000 B.C., is not separated stratigraphically by a sterile zone from the overlying El Dorado phase component. The Chelsea phase component is differentiated on the basis of markedly different projectile point shapes; the bifacially chipped points are short, broad bladed, have a distinct shoulder, and an expanded base. Tools associated with the Chelsea points include knives, a drill, choppers, and grinding stones. This small sample of tools (32), the faunal remains (deer, bison, antelope, rabbit, raccoon, and box turtle), the floral remains (walnut and chenopod), and the excavated features (2 hearths, 3 postmolds, and 2 storage pits) indicate that this component may also be a base camp.

A backhoe trench cut through portions of the west terrace in 1971 transected a burned limestone concentration at a depth of 2.5 m. below present ground surface. Although no diagnostic artifacts were found with the limestone, the trench showed that there are 1.0 m. of culturally sterile soil separating the Chelsea component from the more deeply buried limestone feature. Thus, there can be no doubt that one prehistoric component, and possibly others, lie buried below the Chelsea phase deposits.

The Falconer site, 14BU50, is located 0.4 km. upstream and on the right (north) side of Bird Creek (Fig. 1.3). The cultural deposits were buried, but were found eroding from the side of an arroyo. The site, completely excavated in 1972 (Bradley 1973), consisted of eight discrete occupation zones defined on the basis of vertical clusterings of tools, features, and faunal remains. These zones extended to a depth of two meters below present ground surface, at which point limestone bedrock was encountered in the eastern portion of the excavation. The estimated horizontal extent of the combined occupations is 480 square meters.

Excavated features include 4 hearths (small circular areas of burned limestone and charcoal) and 2 postmolds. The postmolds were associated with a hearth and a fired mud dauber nest; this feature complex was interpreted as evidence for the former presence of a dwelling. A total of 52 chipped chert tools, recovered from the eight activity areas, includes bifaces, projectile points, scrapers, drills, celts, and retouched and utilized flakes. A single worked deer antler tine, 4 chert cores, and a large amount of debitage complete the artifact assemblage. The faunal collection contains a prairie dog, deer, pocket gopher, rabbit, coyote, fox, turkey, and box turtle. Fresh-water mussels were also utilized and occur in all but the uppermost occupation zone. No charred floral remains were recovered from 27 water-floated soil samples taken from the eight activity areas.

The chipped stone tools represent hunting, butchering, and woodworking activities; the cores, debitage, and antler tine demonstrate that chert tools were made at the site. Faunal remains indicate that food items were procured from the upland prairie, riverine, breaks, and floodplain forest resource zones. The hearths and possible dwelling suggest that food preparation and consumption activities occurred on the site as well. Falconer's eight occupation zones were interpreted as intermittent, temporary hunting camps.

Milbourn (14BU25, Fig. 1.3) is another multicomponent Archaic site similar to Snyder (14BU9). The site was briefly tested in 1968 and 1971, but the specimens have not been studied extensively. The archeological deposits appear to contain at least one possible base camp and probably two or three temporary hunting camp components. Faunal and floral remains are supposedly well preserved in pits, but their occurrence is spotty. The stone tool assemblages contain projectile point types that are common in the Southern Plains. The Archaic components at Milbourn may represent population intrustions into the area from the Southern Plains or they may represent indigenous occupations that are not represented in the stratigraphic sequence at Snyder. However, since the 14BU25 materials have not been analyzed, all of the above must be viewed with caution since the statements are unsubstantiated opinions.

14BU4 is a multicomponent site located on the left (east) bank of the Walnut River about 0.5 km. north of the mouth of Satchel Creek (Fig. 1.3). 14BU4 was tested in 1974 (Fulmer 1976), so it is known for certain that there are three components. The Plains Village and Woodland components are mostly churned up in the plowzone; some storage pits extend below cultivation disturbance. A Chelsea phase Archaic component is separated from the ceramic bearing deposits by 25 cm. of culturally sterile soil; it occurs from 90 to 140 cm. below present ground surface. Due to agricultural activities during the 1974 field season, the excavation crew was not allowed to investigate the principle surface concentrations of Plains Village and Woodland materials.

Excavations down into the Archaic component on 14BU4 recovered a small number of chipped stone tools. A single projectile point was recovered that is identical to the Chelsea points found at Snyder (14BU9) and is the evidence for assigning this Archaic component to the Chelsea phase. Other chipped chert tools include a chopper, a knife, and a small number of scrapers. Limestone (both burned and unburned), burned earth, small flecks of charcoal, unrecoverable bone fragments, and fresh-water mussel shell fragments were classes of debris also observed in the excavations. The only feature found in the Archaic component was a concentration of several hundred pieces of chert debitage; all of them had been thermally altered. A considerable number of soil samples were taken for water flotation and screening; but virtually no faunal or floral material, other than small charcoal flecks, were recovered.

The admittedly sparse evidence from the Chelsea component at 14BU4, suggests that the occupation may represent a hunting camp where game was processed and chipped stone tools were manufactured and repaired. Artifact classes, and the activities thought to be associated with them, are fewer in number on 14BU4 than on the Chelsea component at 14BU9; it thus would appear possible that the Chelsea components on 14BU4 and 14BU9 are parts of the same subsistence and settlement system.

The final Archaic site, 14BU92 (formerly 14BU55-West, Fig. 1.3), was tested in 1975 (Fulmer 1977). The site is located on the left (south) side of Bemis Creek and 7.5 km. east of its

mouth. There are probably two Archaic components on 14BU92. Surface collections retrieved from the site contain large, corner-notched or stemmed, projectile points (or hafted knives); large, heavy scrapers; and bifaces. The point forms are styles found in Archaic components on other sites in the area. Not much else is known about the surface component since this site is collected regularly by relic hunters and diagnostic surface debris is difficult to find.

Several test pits were excavated to a depth of 1.0 m.; a buried cultural deposit, probably an Archaic component, was discovered to occur from 50 to 70 cm. below present ground surface. No culturally or chronologically diagnostic artifact forms were excavated; the artifact collection does contain a few broken bifaces, 354 pieces of debitage, and a ground stone spheroid of indeterminate use. No features were discovered, but fire cracked rock fragments and bone fragments were observed. The paucity of information on this buried component at 14BU92 makes interpretation, beyond the fact of its existence, impossible.

The history of Archaic occupations at El Dorado Lake is most accurately described by the stratigraphic sequence and projectile point shape differences among components at the Snyder site (14BU9). The calendar date ranges for the Chelsea, El Dorado, and Walnut phases are estimates based on a small number of radiocarbon dates (Table 1.1). All but one of the radiocarbon assays (N-1279) are

Table 1.1. Radiocarbon dates from archeological sites at El Dorado Lake.

Code	Site	Context	Radiocarbon years B.P. based on half-life 5730	5568	Calendar Estimate[e]	Cultural Historical Tradition
UGa-1347[d]	14BU71	Test 6, Feature 2	740+/-75		A.D. 1210	Plains Village
UGa-1345[d]	14BU55	House 1	890+/-60		A.D. 1060	Woodland
UGa-1346[d]	14BU55	House 1	970+/-80		A.D. 980	
N-769[a]	14BU9	40-55 cm. B.S.[f]		1970+/-110	20 B.C.	ARCHAIC: Walnut Phase
N-1276[a]	14BU9	45 cm. B.S.		2060+/-80	110 B.C.	
N-1552[c]	14BU50	57-88 cm. B.S		3100+/-165	1150 B.C.	
N-1277[b]	14BU9	84 cm. B.S.		3240+/-85	1290 B.C.	El Dorado Phase
N-770[a]	14BU9	Hearth, 100-125 cm. B.S.		3650+/-140	1700 B.C.	
N-771[a]	14BU9	125-140 cm. B S.		3910+/-160	1960 B.C.	
N-1278[b]	14BU9	128 cm. B.S.		3980+/-100	2030 B.C.	
N-1551[c]	14BU9	Hearth, 250 cm. B.S.		4150+/-110	2200 B.C.	Chelsea Phase
N-1280[b]	14BU9	250 cm. B.S.		4600+/-125	2650 B.C.	
N-1279[b]	14BU9	Transition zone, 178 cm. B.S.		4830+/-105	2880 B.C.	Unknown

[a,b,c]Yamasaki, Hamada and Hamada 1972, 1974, 1977. [d]Fulmer 1977. [e]Uncorrected. [f]Below surface.

consistent with stratigraphic superpositioning at Snyder. The 2880 B.C. date from the bottom of the Chelsea component soil zone is inconsistent with the 2650 B.C. and 2200 B.C. dates (N-1280 and N-1551) derived from charcoal obtained from the burned limestone concentration found below Chelsea materials. The date (N-1552, 1150 B.C.) from zone B at the Falconer site (14BU50) appears to place the occupations on that site during El Dorado phase occupations at Snyder. There are two good reasons that Falconer occupation zones are not Walnut phase components as suggested by Grosser (1977): (1) there were no projectile points recovered from 14BU50 small enough to have been suitable as arrow points, yet a mixture of arrow points and atlatl points is a definitive characteristic of the Walnut phase at Snyder; and, (2) the radiocarbon date from zone B at Falconer falls within the estimated time range of the El Dorado phase and there were six cultural deposits below zone B which have to be earlier. Until more dates are made available from Archaic components in the project area, statements on cultural chronology will have to rely on stratigraphic sequences and guesses on contemporaneity based on projectile point similarities.

Present data suggest that during the Archaic occupation of the area, there were significant shifts in the subsistence economies. The Chelsea component at Snyder contains remains of large mammals and a few small mammals; the El Dorado component contains large mammal remains, a large variety of small animals, and charred seeds; the Walnut phase component contained large mammals only. The significance of these resource utilization shifts is not entirely clear, but a similar pattern shows up when fish, bird, and mollusc remains are examined for Snyder. The number of species used is low in the Chelsea component, reach maximum variation in the El Dorado deposit, and disappears entirely in the Walnut phase. The same oscillation from species specialization, to diversification, and back to specialization was found at the Falconer site (14BU50). The food resource exploitation changes detected at Snyder and Falconer may be related to climatic and ecosystem changes, sampling inadequacies, changes in food preferences, functional differences among components, or to changes in procurement technology. Evidence for changes in hunting technology are clearest in the Walnut phase Archaic component on Snyder where projectile points suitable for both the atlatl and the bow and arrow were recovered. Projectile points from earlier Archaic components are too large for tipping arrows, but were suitable for tipping atlatl darts.

Much less is known about the Woodland and Plains Village occupations in the project area. The Butler phase Woodland component at the Snyder site was discussed above. In addition to the Snyder component, there are three other tested sites in the El Dorado Lake project that contain Woodland components: (1) 14BU55 (formerly 14BU55-East), (2) 14BU70, and (3) 14BU19 (Fulmer 1976, 1977). 14BU55 is located on the south (left) bank of Bemis Creek about 8.4 km. upstream from its mouth. The site is immediately upstream from 14BU92; 14BU55 and 14BU92 may in fact overlap each other horizontally. A road grader was used to push aside the plowzone in an area where charcoal and burned earth exhibited

surface concentrations. The test trench revealed a dark stained area of unknown shape and size that contained considerable amounts of burned earth, daub, and charcoal. The excavation also exposed a metate resting on top of an underground storage chamber. No postmold pattern was observed. The stain, burned daub, and charcoal (from probable structural timbers) indicate that the trench uncovered the remains of a prehistoric Woodland house. Unfortunately, the structure was discovered too late in the summer; the field crew ran out of time and funds before the excavation could be completed, so they protected the dwelling's remains and backfilled the test trench.

Pot sherds recovered from 14BU55 are tempered with indurated clay and have cord marked exterior surfaces. The cord markings had either been purposefully or accidentally obliterated on most sherd exteriors; those few that had well preserved cord impressions exhibited 2-ply S-twisted cords that varied from 1 to 3 mm. in diameter. Two sherds were rim sherds; one had a rounded lip, the other had a flattened lip. Chipped chert tools include large and small projectile points, a unifacial knife, side scrapers, choppers, a core tool, bifacial knives, and a probable point preform. The projectile points are either large and corner-notched or stemmed, or are small and corner-notched; all forms are basically triangular in gross outline. A complete specimen of the small, triangular, corner-notched form was recovered from the dwelling along with most of the ceramics described above. Ground and/or pecked stone tools include a celt or adze fragment, a hammerstone, and the metate left in situ. Soil samples from the probable dwelling were water-floated and screened for microdebris. Among the materials recovered are several kilograms of daub with grass impressions, thousands of chert flakes, many grams of charcoal, hundreds of tiny bone fragments, and some charred seeds. The only identified fauna reported is box turtle; some of the flora were tentatively identified as maize kernels. Two radiocarbon assays (see UGa-1345 and UGa-1346, Table 1.1) were taken on charcoal samples thought to have come from the house's roof timbers that burned and fell to the floor.

The tools from 14BU55 indicate that implement manufacture and repair, butchering, hideworking, woodworking, plant processing, and other domestic activities took place on the site. The features described above suggest that most of those activities took place in or in the vicinity of houses. Thus, 14BU55 may be a Woodland village that was economically supported by hunting, gathering, and some horticulture. The Butler phase Woodland component on 14BU9 may also be the remains of a village similar to the one on 14BU55; the two components are similar in size (surface area) and have roughly similar tool assemblages. Obvious differences between them are the lack of known cultigens on 14BU9 and the presence of calcite tempered, zoned, dentate stamped pottery versus the presence of cultigens and the indurated clay tempered, cord marked pottery on 14BU55. It seems reasonable to suggest that other differences will be found if the two components are investigated in the future; there should, at least, be chronological separation.

14BU19, another Woodland site, is located on the east (left) bank of the Walnut River 1.0 km. downstream from the mouth of Cole Creek (Fig. 1.3). Text excavations (Fulmer 1976) were placed on areas of high surface debris density. Cultural remains were found in the plowzone and to a depth of 40 cm. below present ground surface.

Ceramics retrieved from 14BU19 have cord marked exterior surfaces; their temper varies from indurated clay, limestone, and sand to mixtures of all three. Out of 110 specimens, seven are rim sherds with either flattened, rounded, or expanded lips. The projectile points found on the site include the usual small, triangular, either unnotched or corner-notched forms; and large, triangular, corner-notched forms. A small pointed biface fragment, probably a projectile point tip, was found embedded in a deer vertebra. The rest of the chipped stone tool assemblage is composed of knives, drills, choppers, and scrapers; pieces of ground hematite and pitted stones make up the ground stone collection. Burned and unburned limestone, burned earth, charcoal flecks, bone fragments, and mussel shell fragments were observed in the excavations. Thirteen features were detected and investigated; there were two hearths and ten probable trash filled storage pits. Identified faunal remains include deer and rabbit; floral remains were identified as polygonum and chenopod.

A consideration of the tool assemblages, features, and floral and faunal remains, led the investigator (Fulmer 1976) to conclude that 14BU19 was an intermittently occupied hunting camp. The distribution of surface debris and chemical tests made on soil samples indicated that the site was small (in surface area). The flora and fauna recovered from 14BU19 were interpreted as evidence for occupation during late summer and/or early fall. Activities that may have occurred on the site include butchering, hideworking, plant processing, cooking, the preserving and storing of food items; the site is inferred to have been the base from which hunting and gathering groups ventured in search of food.

14BU70, a multicomponent site tested in 1975 (Fulmer 1977), is located on the left (east) bank of the Walnut River some 500 m. downstream from the dam axis (Fig. 1.3). The plowzone on 14BU70 contained a mixture of Woodland and Plains Village artifacts; the Woodland component extended to a depth of 40 to 50 cm. below present ground surface. No features were found in the excavations.

The evidence for a Plains Village occupation is composed of ceramics and projectile point forms. The 15 thin body sherds are tempered with shell or sand, and have exterior surfaces that are well smoothed or cord marked. This small sample of sherds resembles ceramics known from the Great Bend, Lower Walnut focus (Wedel 1959). Projectile points that are shaped like isosceles triangles with straight sides and base, and either with or without notches on the sides are probably associated with the ceramics. Large triangular, corner-notched points were found in the plowzone mixed with the Plains Village artifacts and, also, in the subplowzone cultural deposits that were not disturbed. However, no ceramics are re-

ported to have come from the buried component. The chipped stone tool collection from 14BU70 contains a drill, cores, celts, knives, scrapers, and utilized flakes. Additional artifact classes include hammerstones, fire cracked rocks, and limestone (burned and unburned). Bison, canid, and deer are the identified fauna; charred seeds were recovered from flotation samples but were not identified.

The specimens recovered from 14BU70 have not been extensively analyzed, so it is difficult to determine the significance of the two components. A consideration of the tool collections, lack of features, and limited faunal and floral remains, suggest that the Plains Village and probable Woodland components may both have been temporary hunting camps. This interpretation is only a reasonable guess based on insufficient data.

14BU71 is located on the left (east) bank of Cole Creek 2.0 km. upstream from its mouth (Fig. 1.3). Surface debris covers some 16 hectares, but much of it was exposed by flood scouring. The cultural deposit extends from the present ground surface to a depth of 50 centimeters. Artifacts recovered at 14BU71 are attributable to a Plains Village occupation (Fulmer 1977).

Pottery sherds are tempered with shell, crushed rock, and indurated clay; exterior sherd surfaces are smoothed or cord marked. Body and rim sherds alike are quite thin; the rims have flattened and rounded lips. Complete vessels are inferred to have been restricted neck jars of variable size. Projectile points shaped like narrow isosceles triangles with straight sides and base, either with or without side-notches, are associated with the ceramics. Double beveled knives of the Harahey type, stemmed knives, choppers, scrapers, and utilized flakes and blades comprise the rest of the lithic assemblage. Most of the chipped stone tools are made of locally available cherts, but a small number are made from Alibates chert. The closest known source of Alibates is in the Texas Panhandle (Shaeffer 1958).

Hammerstones, mauls, and metate fragments were recovered during the testing along with fire cracked rock, bone fragments, burned earth, and limestone fragments. Excavated features include two hearths and two trash filled storage pits. Identified mammal bones represent bison, a canid, a raccoon, deer, and a mole; floral remains were recovered by water flotation, but have not yet been identified. A charcoal sample excavated from an undisturbed feature yielded a radiocarbon date of approximately A.D. 1210 (see UGa-1347 in Table 1.1).

14BU71 is clearly an unmixed Plains Village site; the ceramics and projectile points are similar to those ascribed to the late component at 14BU70 and are probably attributable to the Great Bend, Lower Walnut focus. The numbers and kinds of artifact classes recovered from the site indicate that it may have been a base camp or a small village, possibly occupied during a seasonal round.

In summary, the Woodland occupation in the El Dorado Lake area seems to have functional differentiation among sites; there are villages, hunting camps, and burial mounds (the mounds have long since been destroyed, Meade 1905). The villages seem to be very large in surface area; uncontrolled surface collections and limited test excavations suggest that they contain dwellings, food processing and storage areas, and trash disposal locales. Woodland hunting camps appear to be considerably smaller than the villages. Subsistence appears to have depended on hunting large and small mammals, and the gathering of wild plant foods early in the Woodland sequence; limited horticulture may have been added to the economy during later Woodland times. The variability in Woodland ceramics and projectile points may mean that there is a sequence of Woodland occupations in the project area that is comparable, in terms of complexity and differentiation, to the Archaic occupational sequence. Present evidence (Table 1.1) indicates that the Woodland sequence may be bracketable in the span A.D. 1 to 1100. The presence of both atlatl and arrow points in the late Archaic and early Woodland raises the possibility that a record of a Woodland development out of the Archaic may exist in the El Dorado Lake locality.

So little is known about the Central Plains Village Tradition sites at El Dorado Lake that no summary can be made. It is not certain if the post A.D. 1100 components are related to the Great Bend, Lower Walnut focus. Conceivably, Great Bend populations residing near the mouth of the Walnut River used the project area for hunting and gathering, or actually built villages in the locality. Additional Plains Village components may be detected when the site survey is completed or when larger surface collections are examined for mixture of Woodland and later materials.

ORIENTATIONS FOR FUTURE RESEARCH

The general problem orientation for future archeological investigations at El Dorado Lake can be characterized as cultural ecological in nature. The overall objectives are to acquire an understanding of the synchronic and diachronic interrelationships among prehistoric settlement and subsistence systems within the locality, and the environmental conditions to which those cultural subsystems were adapted. An ecological analysis of prehistoric subsistence and settlement patterns is an appropriate research strategy for a geographic area as large as the El Dorado Lake project (cf. Binford 1964; Struever 1968; Plog and Hill 1971; Flannery 1968, 1976; Zubrow 1975). The paragraphs which follow review the status of previous archeological surveys and excavations, discuss the specific problem orientations that can guide future work, and discuss how those investigations can be conducted in order to accomplish the proposed research goals.

RECONNAISSANCE

Previous surveys at El Dorado Lake have contributed to our knowledge of the regional culture history. There are 49 known sites located on federal property; they contain at least 51 distinct archeological components representing the Plains Archaic, Woodland, and Village cultural traditions (cf. Willey and Phillips 1958; Willey 1966; Wedel 1961). Conspicuously absent is any evidence for Paleo-Indian occupation of the area. The most recent studies of site distributions in the project locality present preliminary analyses of prehistoric settlement location patterns (Barnes and Lubovich 1974; Fulmer 1976). Most known archeological sites are situated in the river or creek bottoms within 400 m. of a permanent water supply (Fig. 1.3). Aboriginal site placement is thus thought to have been largely determined by ease of access to water, raw materials for habitations and fuel, and exploitable subsistence resources; the protection of dwellings and people from severe weather has been proposed as an additional factor.

A reconsideration of extant site survey data reveals that there are a number of problems with the above settlement pattern interpretations and serves as a heuristic device from which to formulate future problems and strategies. These problems are partially inferrable from a close inspection of Table 1.2 and Figure 1.3, and generally fall into two broad categories: (1) inadequate data and (2) survey bias.

The first problem encountered is the inability to assign currently recorded sites and/or components to one or more of the four major cultural traditions defined in the Central Plains historical sequence. It was noted earlier that 23 components have undetermined cultural affiliations; the surface collections gathered from those sites do not contain the requisite diagnostic artifact classes or styles that allow formulation of basic hypotheses as to cultural affiliations and chronological positions. Other than their locations and that their surface collections contain a handful or two of chert chips, very little is known about those particular sites. Even for most of the numerous Archaic and Woodland sites, it is not known what kinds of components they contain; they may be base camps, hunting camps, butchering stations, burial areas, or some other type of site. There is no information concerning functional artifact classes so no hypotheses can be proposed about activity composition, whether technological, subsistence, household, ceremonial, or otherwise. Most of the sites have not been mapped, so there are no data on component size and internal surficial distributions; nor is the vertical depth of most buried deposits known. Without this sort of basic information, it is impossible to offer hypotheses on site structure or to intelligently plan subsurface tests and excavations. The inadequacy of present survey data should, by now, be clear; yet no consideration has been given to cultural change, ecosystem change, warfare, demography, raw material sources, interregional exchange systems, and a host of other problem areas and questions that can be applied to site survey data.

Table 1.2. Initial level of investigation recommended under the research design for archeological sites recorded at El Dorado Lake as of 1976.

		Recommended Action			
Site Number	Cultural Affiliations	No Further Work	Surface Survey	Subsurface Test	Excavate
14BU3	Woodland	-	x	x	-
14BU4	Archaic & Woodland	-	-	-	x
14BU5	Woodland	-	x	x	-
14BU6	Unknown Prehistoric	-	x	x	-
14BU7	Woodland	-	x	x	-
14BU8	Archaic	-	x	x	-
14BU9	Archaic & Woodland	-	-	-	x
14BU10	Woodland	x	-	-	-
14BU13	Archaic & Woodland	-	x	x	-
14BU14	Unknown Prehistoric	-	x	x	-
14BU15	Unknown Prehistoric	-	x	x	-
14BU16	Woodland	-	x	x	-
14BU17	Unknown Prehistoric	-	x	x	-
14BU19	Woodland	-	x	x	-
14BU20	Unknown Prehistoric	-	x	x	-
14BU21	Unknown Prehistoric	-	x	x	-

Table 1.2. (continued)

Site Number	Cultural Affiliations	Recommended Action: No Further Work	Surface Survey	Subsurface Test	Excavate
14BU22	Unknown Prehistoric	-	x	x	-
14BU23	Unknown Prehistoric	-	x	x	-
14BU24	Woodland	-	x	x	-
14BU25	Archaic	-	x	x	-
14BU26	Unknown Prehistoric	-	x	x	-
14BU27	Woodland	-	x	x	-
14BU29	Woodland	-	x	-	-
14BU30	Unknown Prehistoric	-	x	x	-
14BU31	Woodland	-	x	x	-
14BU32	Woodland	-	x	-	-
14BU37	Unknown Prehistoric	-	x	-	-
14BU51	Unknown Prehistoric	-	x	x	-
14BU52	Unknown Prehistoric	-	x	-	-
14BU53	Unknown Prehistoric	-	x	x	-
14BU54	Archaic	-	x	x	-
14BU55	Woodland	-	-	-	x
14BU56	Archaic & Unknown Prehistoric	-	x	x	-

Table 1.2. (continued)

Site Number	Cultural Affiliations	Recommended Action: No Further Work	Surface Survey	Subsurface Test	Excavate
14BU57	Unknown Prehistoric	-	x	x	-
14BU59	Archaic	-	x	x	-
14BU60	Archaic & Woodland	-	x	x	-
14BU61	Unknown Prehistoric	-	x	-	-
14BU70	Village	-	x	x	-
14BU71	Village	-	x	x	-
14BU72	Woodland	-	x	-	-
14BU73	Unknown Prehistoric	-	x	-	-
14BU74	Archaic	-	x	x	-
14BU75	Unknown Prehistoric	-	x	x	-
14BU76	Unknown Prehistoric	-	x	x	-
14BU77	Unknown Prehistoric	-	x	-	-
14BU78	Unknown Prehistoric	-	x	x	-
14BU79	Unknown Prehistoric	-	x	x	-
14BU80	Unknown Prehistoric	-	x	x	-
14BU81	Unknown Prehistoric	-	x	x	-
14BU92	Archaic	-	x	x	-

The other major defect with extant data is survey bias. It was mentioned above that all recorded sites in the project lie within 400 m. of the Walnut River or one of its tributary creeks. The distribution of archeological sites shown in Figure 1.3 may actually be an accurate picture of the prehistoric settlement patterns, regardless of whether the components are Archaic, Woodland, Plains Village, or whatever. However, it is equally likely that the recorded site density is high in the river and creek bottoms because that is where sites are easiest to find and the only place that has been searched.

The preliminary pedestrian site reconnaissance has been completed for the surface area within the boundaries of the lake's flood pool (Fulmer 1977). Figure 1.3 shows that the extant survey is weak or nonexistent in several important areas. Judging from site distributions and local densities on the Walnut River, and the lower reaches of its major tributaries, there are some areas of unexpected low site density: (1) along certain stretches of the Walnut River, (2) all of Satchel Creek, and (3) the middle reaches of Durechen Creek.

Future research should attempt to determine why there are clusters of sites in some places and no sites in others. Perhaps some localities, such as near the mouths of creeks, were especially suitable for building prehistoric villages because of easy access to food, water, or other resources. Specific locations may have been avoided because they were far from active game trails, difficult to defend, or exposed to severe weather. Yet other seemingly bare stretches of bottoms may have contained sites that were destroyed by stream meandering; another possibility is that the sites in such areas still exist but could not be found because they are buried by flood borne deposits or hidden by heavy surface vegetation. Thus even though many of these areas have already been examined, the problems pointed out with known site distributions and the paucity of archeological remains in some areas strongly suggest that further investigations are warranted. In addition to the above considerations, the proximity of recorded sites to permanent water indicates that river and creek banks need to be thoroughly searched for buried cultural deposits. Another serious source of survey bias is the lack of work in areas above the lake's flood pool. The breaks and upland prairie zones located between the flood pool and federal property boundaries have not been investigated and must be examined.

Since something on the order of 90-95% of the prehistoric sites in the project area will never be excavated, the survey and test excavation data are extremely important. Furthermore, to enable a detailed study of settlement location patterns, the reconnaissance and small scale test excavation programs proposed here must record more data than just the mere presence or absence of sites in the project area. The problems posed, the questions asked, and the information to be collected fall into five categories: (1) site attributes, (2) the relationships of sites to subsistence resource zones and raw materials, (3) the relationships of sites to geomorphological and meteorological variables, (4) intersite rela-

tionships, and (5) data reliability. The site survey and testing programs can systematically proceed according to the interdependent phases of investigation discussed below.

The first step is to complete the site survey and attempt to locate all surficial components. This means that every square meter of federal land in the project area must be examined for prehistoric cultural debris. As noted above, there are several areas of project lands that have either not been surveyed at all or were not surveyed very well. This preliminary and basic search for sites will provide the Corps of Engineers with the information needed to compile the inventory of archeological resources required by Executive Order 11593. The inventory will specify the relationships of recorded sites to various project features, such as the dam axis, multipurpose and flood pool elevations, recreation areas, buildings, and property boundaries. These data will also be useful for formulating a cultural resource management plan for those sites not impacted by inundation, shoreline erosion, construction, and other destructive agencies. Information on site locations, distributions, and densities can be used to help formulate hypotheses about settlement patterns and the relationships of those patterns to potential subsistence resources, raw materials, and protection from harsh weather, warfare, floods, and so on.

TEST EXCAVATIONS

The test excavation strategy has two general purposes: (1) to obtain information about site size and depth, the stratigraphic relationships of multiple components, the relative state of preservation of cultural debris and refuse (especially faunal and floral remains), and a profile of the soils both on and off each site; and (2) to provide a critical data base from which to select sites for large scale salvage excavation. This phase of future investigations is specifically designed to focus on intersite variability.

In addition to knowing where archeological components are and are not located, the surface area or areal distribution of all surficial deposits must be determined. Every archeological site in the impact areas will have a contour map prepared that illustrates the nuances of local relief and the observable boundaries of cultural debris. For some surface components the vegetative cover will have to be cleared; it may even be necessary to disk or plow in order to determine artifact distributions. From a study of site size variability the investigator can propose hypotheses concerned with human demography, settlement function, and depositional history. When site data are considered in conjunction with location, distribution, and density data, additional problems emerge, such as the seasonal and functional interrelationships among sites.

A surface collection will, of course, have to be retrieved from every investigated site. If it is warranted and feasible, a systematic surface collection obtained within a two meter grid

system will allow some control over artifact distributions and covariances. If the component's surface area is small, the entire site can be surface collected within the two meter square provenience units. If the component is large, it will be necessary to sample the exposed surface debris. An interval surface sampling design will guarantee an even and patterened sample of artifacts. A stratified random sample is most appropriate when the investigator already knows something of the internal structural differentiation within a site. A simple random sample is usually the least productive sampling strategy because it does not produce an even distribution of collection units over a surface component. If there are conditions that make a controlled surface collection unwarranted or unfeasible, such as heavy vegetation or crop cover, heavy and frequent amateur collecting, low artifact density, or any factor that decreases debris visibility, it will be necessary to revert to a grab surface collection. Even though this kind of artifact retrieval is less controlled than the gridded collections, it need not be uncontrolled; observations can still be made about differential debris densities and apparent covariances. Such observations will be less reliable and replicable, but they will still be useful as long as the investigator is aware of their limitations.

The analyses of surface collections should provide the archeologist with some idea on the cultural affiliations of surface components and whether the surficial deposit on any given site is single or multicomponent. A knowledge of the cultural affiliations of each site will allow the separation of components that were occupied during different historical periods. For sites with the same cultural affiliations, questions can be asked about contemporaneity, and roles in subsistence and settlement systems. Surface collection analysis will generate information on what kinds of raw materials (chert, sandstone, limestone, clay, quartzite, etc) were procured and used by the inhabitants. The investigators will need to know how those materials were procured, where they came from, and whether or not their sources were a factor that influenced settlement location. Every material item brought to a site was, at least, procured; some were modified into tools and implements, but most items were probably used in some way or another and were finally disposed of, stored, or lost. Analyses oriented toward obtaining these kinds of data should be accomplished for every site in order to determine the possible number and kinds of activities that took place. Since the project as a whole is designed to study subsistence and settlement systems, there is particular interest in the functional artifact classes that articulated human behavior with the food items and raw materials that comprised the economically important portions of prehistoric man's environment.

Once hypotheses concerned with prehistoric activities and behavioral sequences have been tested against functional and technological artifact studies, the problem of artifact distributions and associations within the sites can be approached. Since the surface collections are to be made within units of a site's grid system, there will be control over artifact provenience; from that it can easily be determined which classes of debris co-occur, which do not, and how they are distributed over the site's surface.

These studies will promote the positing of hypotheses on the number, kinds, and locations of activity areas. There will be a specific concern with propositions about food processing, cooking, and consumption areas; storage areas; trash disposal areas; tool manufacturing and utilization areas; and all other activities that emerge from initial analyses. The analysis of controlled surface collections should allow the detection of horizontal site structure rather than just the limits of random debris. Furthermore, it is expected that these data will help the sorting out of or detection of mixed surface components. They will also provide more refined checks and tests of hypotheses on site size, cultural affiliation, and chronological placement. Seriational studies of artifact styles may result in tighter control over the locality's culture history by detecting stylistic clusters (horizon markers), discontinuities (occupational hiatuses), or developmental sequences. But, most importantly, these investigations can posit and test propositions about specific site functions and so link contemporary and functionally complementary sites into subsistence and settlement systems.

The next step in the testing program will be to actually place two or three small (two meter square) excavation units on every impacted site in the project area. This limited subsurface testing can be done rapidly because it is designed to determine site depth, the stratigraphic relationships of multiple components, the relative state of preservation of cultural refuse, debris, and features, and a profile of the soil bodies both on and off the site. Text excavations should be placed on the site so as to maximize the amount of data indicated above. However, the precise location of each test pit will depend on a knowledge of site boundaries, the kinds and distributions of activities within those boundaries, and the information obtained from analysis of the surface collection. Because there is explicit interest in subsistence data, for example, it might be appropriate to place one test excavation in a trash midden, if one was posited from earlier analyses. One test pit should be placed beyond the posited site boundaries. The purpose of this excavation is to inform the investigators about the nature of culturally undisturbed soil bodies. A comparison of soil horizons and stratigraphic units obtained from culturally disturbed and undisturbed areas helps the archeologist to detect and corroborate the existence of cultural layers and horizons in a site's soil profile. These contrastive soil profiles can also be studied by consulting scientists for information on soil formation processes, depositional history, and climatic and other environmental changes.

As information accumulates from the survey and testing program, project archeologists can turn their attention to enquiries of a more inclusive systemic nature. The analytical problems are to determine, in so far as possible, intersite, developmental, and interregional relationships. Data will accumulate on where surficial components are and are not located and on their size, cultural affiliation, and chronology. The subsurface tests will have provided information on site depth, number and kind of buried components, what kinds of features can be expected, and some knowledge of what faunal and floral remains are present. These data can be used to

answer, or at least approach, questions about which presumably contemporary sites functioned together as parts of subsistence and settlement systems. The broad outline of the locality's culture history is already known. What is not known is whether or not the area was continuously occupied since man's first appearance in the area, whether there was an in situ cultural development from Paleo-Indian to protohistoric times, whether the area went through a series of abandonments and reoccupations, or whether there was some combination of all these possibilities. Thus, questions can be asked of the data about developmental continuities and discontinuities, about population movements into or out of the locality, and about interregional contacts via trade, warfare, diffusion, and so on.

Throughout all of the archeological and environmental enquiries discussed in this paper, the project scientists will gather the information necessary to make judgements about possible sources of bias in the project's data. For example, historic land use patterns, limestone quarrying, timber cutting, channel straightening, surface visibility, amateur artifact collecting, pothunting, road building, and many other factors can skew or invalidate analytical results. An evaluation of data reliability is an analytical desideratum for each and every phase of the project. The data base will definitely be biased, even if for no other reason than that investigations are constrained, by contract, to occur within the boundaries of a federal project. The source and extent of data bias must be known so that hypotheses, analyses, and interpretations may be properly adjusted to compensate for those limitations.

The above paragraphs have attempted to: (1) discuss the problem orientations and data needs required for settlement pattern enquiries and (2) outline the fieldwork and analytical steps by means of which the relevant data can be procured. It must be emphasized again that the proposed reconnaissance and testing programs are extremely important. Most of the sites located in the project area will never be excavated. The test excavation data will comprise all that is known about those sites and therein lies the importance of the mapping, surface collecting, and limited testing. Only two sites at El Dorado Lake are not recommended for this more intensive level of investigation: (1) 14BU10, a Woodland site, was systematically surface collected and mapped in 1969, and has since been largely destroyed by shoreline erosion of Lake Bluestem; and, (2) 14BU38 was an historic family graveyard that has been moved. Details for the other sites threatened by project impacts and recommended for mapping, surface collecting, and limited subsurface testing are presented in Table 1.2.

SALVAGE EXCAVATIONS

The salvage excavations will focus on three general problems: (1) the primary objective is to gather sufficient data to quantitatively test hypotheses on prehistoric subsistence patterns; (2) to provide soil samples, soil profiles, specimens, data, and

problems for the paleoenvironmental investigations being conducted by consulting specialists; and, (3) to provide well controlled artifactual content, provenience, associational, and contextual data for further testing and refinement of the settlement location hypotheses discussed in previous paragraphs. The large excavations will be of the type called "block excavations"; they are specifically designed to investigate intrasite structure, i.e., a component's horizontal variability and patterning. Block excavations will be placed on components representing each cultural affiliation, time period, and settlement function as determined by or proposed from analyses and tests accomplished during the test excavation program.

The primary field strategy will be to design and implement a series of block excavations that will retrieve a maximum amount of data with which to approach a whole series of more specific problems: for example, (1) what kinds of faunal and floral resources were being exploited, (2) what are their relative frequencies, (3) what were their contributions to prehistoric diets, (4) how were food resources procured, processed, cooked, consumed, preserved, and stored, (5) where were food items procured, processed, cooked, consumed, preserved, and stored, (6) were food items traded in intra- and inter-community exchange systems, (7) was there a division of labor in subsistence activities, (8) were food procurement activities scheduled to maximize exploitation of seasonally available resources, (9) were any conservation measures taken to insure recurrent and reliable plant and animal food populations, and (10) are the apparent similarities and differences in food item frequencies a product of site function, cultural preferences, seasonal availability, efficient procurement techniques, ecosystem changes, or sampling error?

Given the data requirements to be met by implementation of block excavations, there are innumerable different ways to accomplish the same goal. Day to day field techniques and operations will, of course, have to be adjusted to the specific, but unpredictable, conditions encountered on each site. It is possible, however, to outline some broad principles that should be used to insure comparability of data quality and results. Thus, for example, a well planned block excavation on a multicomponent site, such as 14BU9, could sample and gather information from several different cultural taxa and possibly even functionally differentiated settlement types. Such an excavation on one site is clearly preferable to separate block excavations on many different sites; it is efficient and has the added attraction of sampling undisturbed deposits in a previously determined stratigraphic sequence.

Stratified multicomponent sites confront the archeologist with a number of sampling problems. The distribution of surface debris usually indicates that there are several more or less equally good places to lay out an excavation, but the idea is to start the excavation in that particular location that will allow the field crew to continue down through the underlying components without having to shift around on the site. The solution to this problem, if there is a solution, can be obtained in at least two

ways; the horizontal extent of buried components can be determined (1) through analysis (visual, mechanical, and/or chemical) of soil samples obtained with a deep sampling core or (2) by cutting trenches through the components (horizontally and vertically) with heavy machinery, such as a backhoe. An understanding of the distribution of a buried component will help the archeologist plan an excavation that won't entirely miss a buried deposit and can certainly be used to determine how a block excavation's dimensions can be adjusted to acquire an adequate sample. The dimensions of the excavation can be changed to compensate for different component sizes. Making these adjustments with power equipment is destructive, but may be necessary. It must be remembered that the archeological project has to complete its fieldwork before the dam closes in 1980. The block excavations can not be conducted at leisure, portions of some components may have to be destroyed in order to adequately sample others.

Once the required surface area of each target component has been exposed, the actual digging will be conducted with the usual hand tools (trowels, shovels, brushes, etc.). The two meter grid system already established for each site can be used to maintain provenience control over the location of features and portable specimens. The individual provenience units can be dug in horizontal cuts according to noncultural stratigraphic soil bodies, if they exist, or by arbitrary vertical units, or some appropriate combination of both. Individually detected artifacts will be plotted in three dimensions and notes taken on their context of discovery and associations. The backdirt from every excavated unit and level will be screened through a sifter to recover small specimens that may have been missed. The cultural debris recovered by this means will be bagged as a unit for subsequent processing and analysis.

The locations from which soil samples are taken should be chosen carefully for they are designed to sample the microartifactual, faunal, and floral remains deposited on old living surfaces. Horizontal concentrations of plotted specimens and feature origins are the key to finding former ground surfaces. These soil samples will be submitted to water flotation first, so that fragile charred plant remains can be floated to the surface and collected before the mechanically rougher water screening begins. The soil matrices of all features will also be sampled for pollen extraction and soils analyses. The entire remaining soil matrix from each feature will be water floated and screened for microdebris. Unusable features, such as spoiled storage pits, were often filled with general domestic garbage; trash filled pits are excellent sources for specimens and data.

The floor of each completed excavation level will be scraped clean and flattened, so that it can be inspected for soil stains, mapped, and photographed. Regularly shaped soil stains often signal the presence of some type of krotavina, such as pits, postmolds, hearths, animal burrows, etc. All such stains will be cross sectioned and excavated as provenience units separate from the general levels in which they occur. The cross sections are required for three reasons: (1) to record the stain's vertical

shape and dimensions with profile drawings and photographs, (2) to help diagnose the cultural or noncultural origin of the stain, and (3) if the stain is a cultural feature, to investigate the possibility of internally distinguishable depositional units. All cultural features, however, do not necessarily stain the soil. Bone piles from game butchering, chert concentrations in workshop areas, and concentrations of limestone from roasting pits, for example, will be carefully pedestaled so that element relationships can be determined and properly recorded. In all other respects, concentrations or features that have not stained the soil will be investigated in the same way as features that disturbed the soil.

As noted above, one purpose of a block excavation is to sample the horizontal activity structure of a component. The carefully controlled excavating, specimen and feature plotting, mapping, and recording are the prerequisite data with which hypotheses on association, context, and activity structure are tested. This implies that information derived from the excavations should be processed and analyzed as quickly as possible so that laboratory results can enter into the field decision making processes. Site excavation is primarily a data gathering activity, but if there is timely feedback from the laboratory, hypotheses can easily be adjusted or formulated in the field to take advantage of unexpected sources of information. This kind of feedback loop can greatly expand scientific productivity and increase efficiency.

In summary, the salvage excavations will focus on obtaining cultural and ecological data for formulating and testing hypotheses on subsistence economies, and can also provide data for evaluation of ecosystem and settlement pattern models. The sites chosen for salvage excavation will provide relevant data from components representing all cultural systems, time periods, and functionally differentiated settlement types. On the basis of these criteria, sites to be salvaged include Snyder (14BU9), 14BU4, and 14BU55: 14BU9 contains more than three Archaic components and a large Woodland component; 14BU4 contains a Plains Village, a Woodland, and an Archaic component; and 14BU55 is a probable Woodland village (for more detailed information see the section above on previous research in the El Dorado Lake area). If the Milbourn site (14BU25) is situated on federal property and if the site will be impacted by the project, then this multicomponent Archaic site will also be given a high priority ranking for salvage excavation. The selection of additional sites for block excavation will have to wait on results from the survey and test excavation program.

ENVIRONMENTAL STUDIES

Most of the problems considered in the foregoing were basically concerned with cultural matters per se, i.e., with questions about site locations, distributions, densities, sizes, cultural affiliations; number, frequency, and kinds of activities and activity areas; cultural chronology; subsurface sampling; component structure; and

so on. The ecosystem analysis is not, strictly speaking, a discrete step in the investigations proposed here, but a coordinated interdisciplinary endeavor that will continue during the entire project. The objectives of this portion of the investigations are: (1) to formulate and test synchronic and diachronic models of the environments prehistoric groups had to adapt to in order to survive; (2) to test hypotheses on the relationships between settlement location patterns and the economically important resources and materials in the ecosystem; and, (3) to test hypotheses on the relationships between settlement locations and various geomorphological and meteorological phenomena.

The first item of concern will be to determine which fossil information systems can be maximally exploited in the El Dorado area for paleoenvironmental data. Geomorphological and pedogenic studies will certainly be productive, but the feasibility of palynological investigations will have to be determined from a pilot study. The archeological excavations will produce ecological data and problems for the consulting paleoenvironmental specialists. But, a word of caution, the multifarious sampling and analytical techniques inherent in interdisciplinary research requires that the nonarcheological scientists not be restricted to investigating archeological deposits or be required to stay within federal property boundaries. Their expertise will certainly be utilized in the analysis of archeological remains, but within the total framework of the research program there must be flexibility so that each contributing discipline can design and implement its own enquiry.

The ecosystem studies will be useful for determining the validity of the ecological resource zone model and environmental characterization discussed in earlier paragraphs. For example, the resource zones, as described, may be gross and theoretically useless constructs because they ignore important sources of variability or posit too much variability. Paleoecologists have learned that vast portions of North America went through a series of climatic episodes during the Holocene, and that there were concomitant changes in floral and faunal communities (Baerris, Bryson and Kutzbach 1976; Baerris and Bryson 1965; Bryson and Wendland 1967; Dort and Jones 1970). The ecosystem in the southern Flint Hills may have undergone similar changes or it may have remained stable compared to surrounding regions. There is some evidence from archeological sites inside and outside the immediate project area that prehistoric populations had to adjust or adapt to ecosystem fluctuations (Grosser 1977; Bradley 1973; Lehmer 1971; Schmits 1976, 1978; Wedel 1941, 1953, 1959). These ecosystem changes were inferred from analyses of the plants and animals procured for food by Archaic and later peoples, and could just as easily reflect differential site function, technological change, or food preferences. The ecological change models proposed for the El Dorado locality must be tested against independent data sets, i.e., with information not retrieved from archeological sites.

The locations of utilized mineral sources are a different matter in that they were not subject to the environmental processes

that biological communities may have experienced. In order to test hypotheses on whether or not chert, limestone, sandstone, and other raw materials were important factors in settlement location patterns, one has to know where those minerals are located, which sources were used by whom, and how they were procured. Some materials, such as Alibates chert and quartzite, do not occur locally in the lake area and may have been obtained through trade. The various research teams will have to gather the needed data on raw material sources and distributions in the locality.

Other kinds of needed information include the geomorphological and meteorological conditions of site location. Observations on rank of nearest stream, topographic context, slope, relief, and elevation will help the archeologist and geomorphologist work out the terrace system for the Walnut River and, possibily, its tributary creeks. That the locality's terrace system is a critical factor in prehistoric settlement location patterns is demonstrated by current studies in the nearby Little Arkansas and Neosho River valleys (Rogers 1977). In both river valleys there is a distinct terrace sequence that has been related to Late Wisconsin and Holocene geological events through faunal and archeological assemblages. Buried Archaic sites have been found eroding out of the edge of the first terrace along with a modern fauna in the Neosho and Little Arkansas valleys; the Snyder site (14BU9) has multiple Archaic components buried in the Walnut River valley's first terrace. Since the Neosho River also drains the Kansas Flint Hills, the implications from these river terrace studies are clear. If there is a discernable terrace system on the Walnut River in the El Dorado Lake area, then buried Archaic sites should be in the first terrace and Paleo-Indian sites should be found in the second terrace. Thus, this kind of information can be used to find unrecorded sites in addition to its value for paleoenvironmental studies.

The location of potentially significant geographic features, soil types, and site exposure to air currents and solar radiation are also classes of information useful for settlement pattern studies. Sites may have been situated in any one of a number of suitable locations near water and other resources as long as there was also a convenient overlook (for security or ceremonial purposes), a limestone outcrop (for hearth stones or petroglyph carving), a river or stream cutbank (for game drives or pottery clay), and so on. A knowledge of soil types is useful because soils develop from specific parent materials under reasonably well known climatic conditions and vegetation cover (Ruhe 1970). A study of soil type distributions and stratigraphic relationships can thus test diachronic and synchronic models of climatic conditions and floral resources in the project area. Data on a site's location relative to air current and solar radiation exposure will allow the testing of hypotheses on the relevancy of those variables to settlement placement. For example, villages and camps occupied during the winter months may have been built where they were protected from cold winds or where they could receive maximum exposure to the sun for warmth. Sites occupied during the hot summer months may have been located where inhabitants were shaded from afternoon sunshine and

where the winds were strong enough to cool dwellings and blow away bothersome insects.

CONCLUDING REMARKS

It should be noted that the above division of the archeological research design into broad phases is arbitrary in the sense that they are not unrelated investigative activities through which work must sequentially proceed. The surveys, excavations, and environmental analyses can be conducted simultaneously so that each can be integrated with the others and so that information and findings from one area can be used in another. The above paragraphs have attempted to present the problem orientations and data needs required by subsistence and settlement system enquiries and outline the fieldwork and analytical steps by means of which the project's investigators can procure the relevant data. The process of formulating and testing hypotheses about prehistoric human behavior is cumulative in that lower order and more specific problems must be considered before higher order and more inclusive problems. For example, one needs to know how chert was procured, how chert tools were manufactured, utilized, resharpened, or lost and thrown away before considering problems concerned with how a lithic industry functioned in a social system or how it enabled a human group to adapt to its environment. Finally, it seems quite likely that the project scientists will be confronted with problems and data needs not anticipated in the foregoing discussions; some of the questions asked *above may* prove to be blind alleys or irrelevant. It can be anticipated, however, that within the framework defined by the research design there is enough built-in flexibility to compensate for such unknown contingencies.

CHAPTER 2

ARCHEOLOGICAL SITE SURVEY IN THE EL DORADO LAKE AREA, SOUTH-CENTRAL, KANSAS

Matthew J. Root

INTRODUCTION

An archeological survey was carried out to locate sites in the upland prairie and hillside areas between the flood pool of El Dorado Lake and federal property boundaries, and in areas along the Walnut River and its feeder creeks with unexpected low site density. Previous research had located 51 prehistoric sites within the project area (Eoff and Johnson 1968; Fulmer 1977; Leaf 1976a), some of these were reinvestigated to gather data pertinent to a locational behavior analysis. This work provides additional information needed for completion of the cultural resources inventory required by Executive Order 11593 and the contractual scope of services.

Investigations were conducted to meet the objectives and data requirements set forth in the project research design (Leaf 1976a). Preliminary locational analysis indicated that extant survey data were insufficient for productive study. Problems encountered included lack of diagnostic artifacts on which to base cultural affiliations, little information concerning specific activities carried out at sites, and unknown areal extent of surface components. Stream valleys had only been partially searched and upland areas were unsurveyed, therefore, the true distribution of sites was unknown (Leaf 1976a:30-40).

Several stages of investigation have been set forth to overcome data inadequacies and the kinds of information pertinent to research goals have been outlined in the research design (Leaf 1976a:39-73). The major research orientation is investigation of prehistoric settlement-subsistence systems in the area; data requirements are established in this perspective. The kinds of data collected can be divided into five groups: (1) site attributes, (2) relationships of sites to subsistence resource zones and raw materials, (3) relationships of sites to geomorphological and meteorological variables, (4) intersite relationships, and (5) data reliability. Information which was gathered in the field is as follows. Site attributes include location, surface area, cultural affiliation, and number of surface components. Resource zone and raw material data consist of intermittent water supply sources and locations of raw materials. Geomorphological variables are topographic features such as river meander scars and terraces, stream crossings, and overlook locations and relationships to sites. Data reliability is evaluated by considering current land uses and disturbances, amateur collecting and pothunting, and present vegetation cover (Leaf 1976a, Table 4).

The completion of Phase I work has fulfilled some of the research objectives. All federal property has been searched for surface sites, areal distribution of many surface sites has been approximated, some relationships of sites to the natural environment have been outlined, and the extent of data biases has been partially assessed.

SURVEY TECHNIQUES

Field survey techniques consisted of pedestrian reconnaissance by a crew ranging from eight to ten persons. The entire area between flood pool elevation and federal project boundaries was searched. This land is predominantly upland prairie and had not been previously surveyed. Localities with low site density that were surveyed include: (1) the Walnut River at the northern end of the flood pool, (2) the middle reaches of Durechen Creek, and (3) all of Satchel Creek. In addition, the Bemis Creek valley and adjacent uplands were surveyed for approximately two km. below Lake Bluestem. The remaining portions of Durechen Creek, and much of the Cole Creek and Walnut River valleys were also checked for unrecorded sites. (The exact areas surveyed are delimited in a background data volume presented to the Tulsa District, Corps of Engineers.)

In an effort to evaluate survey data bias, close records were kept of ground surface visibility. A scale was established to report the percentage of ground surface free of vegetation or other cover (Table 2.1). Generally, as ground surface visibility improves, the reliabili-

Table 2.1. Ground surface visibility scale[a].

Poor	0-25% of the ground surface is clear of vegetation or other cover, e.g., ground covered with prairie vegetation or a field overgrown with weeds.
Fair	25-50% of the ground surface is clear of vegetation or other cover, e.g., a mature row milo field.
Good	50-75% of the ground surface is clear of vegetation or other cover, e.g., an immature milo field or a field where crops have been harvested and stalks partially obscure the ground.
Excellent	75-100% of the ground surface is clear of vegetation or other cover, e.g., a freshly disced or recently planted field.

[a]Adapted from Leaf 1977, Table 1.

ty of site location data improves. In other words, it is easier to locate sites in a recently plowed field than it is in the undisturbed prairie. Detailed maps showing ground surface visibility rankings for the surveyed areas are included in the background data volume.

When materials were collected from a location where no artifacts had been previously recorded, that area was designated a "field site"; these were numbered serially in their order of discovery. Such collected materials were subsequently examined in the laboratory. If it could not be conclusively demonstrated that those materials had been modified by prehistoric human behavior, they were discarded. For example, if a few pieces of chert were recovered that were of dubious origin, they were assigned a field site number. They were then brought back to the laboratory for more careful inspection. If their occurrence and form could be explained by natural or modern causes, they were discarded. If the materials were demonstrably of prehistoric cultural origin, the field site was changed to either "find spot" or "archeological site" status.

Find spots are loci where material cultural remains were recovered, but that did not exhibit an internally structured deposit which was the result of prehistoric human behavior. All known cultural materials were removed from find spot loci. Therefore, find spots were not given permanent site numbers, but retain their field site designations (Leaf 1977:13). Examples of find spots are isolated artifact finds or loci where only a few flakes were recovered.

Locations of repetitive and patterned prehistoric human behavior marked by material cultural remains exhibiting an internally structured deposit were called archeological sites. This definition is more practical than definitions which specify that archeological sites are either loci of past human behavior or loci of cultural materials (e.g., Schiffer and Gumerman 1977:183). Definitions which give the necessary and sufficient condition for an area to become a site as a locus of past human behavior are too broad. Under this criterion, for example, a few isolated resharpening flakes would be a site. Under the second criterion, areas of past human behavior not marked by material cultural remains would also become sites, although difficult to establish as such. Definitions of sites aş loci of material cultural remains are also inadequate. This criterion alone does not accurately identify an area as a site, since locations of secondary deposit, such as gravel bars, also become archeological sites by definition. These are not sites, but areas where artifacts currently occur. Therefore, both these criteria together with the specification that cultural materials be present in a structured deposit comprise a more meaningful definition of an archeological site.

As pointed out by Schiffer and Gumerman (1977:184), there are problems in operationalizing this type of definition. Although no specific empirical criteria were set forth prior to investigations, there were several factors on which decisions concerning the final status of field sites were based. As mentioned above, if all cultural materials were removed from a field site during pre-

liminary reconnaissance, it was designated a find spot. This is somewhat subjective in that judgements must be made as to whether any cultural material remains. However, if artifacts were recovered from areas of relatively good visibility, and not from adjacent areas with poor visibility, it was inferred that cultural materials also occurred in the latter locations. In addition, many sites were rechecked after the initial survey. If more artifacts were recovered during secondary investigations, it was inferred that a cultural deposit remained. The presence of subsurface deposits was checked by using soil probes or auger tests. If a subplowzone deposit was present, it was assumed to have some structure. The distribution of surficial deposits was also a factor employed in making decisions. If concentrations were observed that were not a result of differential ground surface visibility, a spatially patterned deposit was inferred.

The use of these criteria does not eliminate every problem in trying to make field decisions as to which field sites are find spots or archeological sites. The operational factors employed are not totally objective. Determinations were partially influenced by subjective judgements. In addition, the demonstration of structure is ultimately a result of laboratory analysis. Although these shortcomings are present, the factors utilized are useful for establishing a preliminary separation of locations of past cultural materials.

Some archeological sites will, of course, exhibit more structure than others. An intact, subplowzone deposit will show a higher degree of spatial patterning than one that has been completely disturbed by modern agricultural practices. However, even in the latter case, some of the original relationships will remain. It is possible that these distinctions may be occasionally obscured by problems in determinacy. Therefore, find spots should be monitored in case ground surface visibility improves or other factors change which offer opportunities to reevaluate past determinations.

Objectives of site reconnaissance were met with a high degree of success. Two new sites in upland prairie contexts and 13 in river or creek valleys were recorded. This brings the total number of known prehistoric sites within the project area to 66. Thirteen find spots were also recorded. Archeological sites and find spots are discussed individually below.

SURVEY RESULTS

Find Spots

Locations of find spots are illustrated in Figure 2.1. The numerical designations refer to field site numbers and should not be confused with permanent site numbers (Smithsonian Institution River Basin Surveys Trinomial Site Designation numbers).

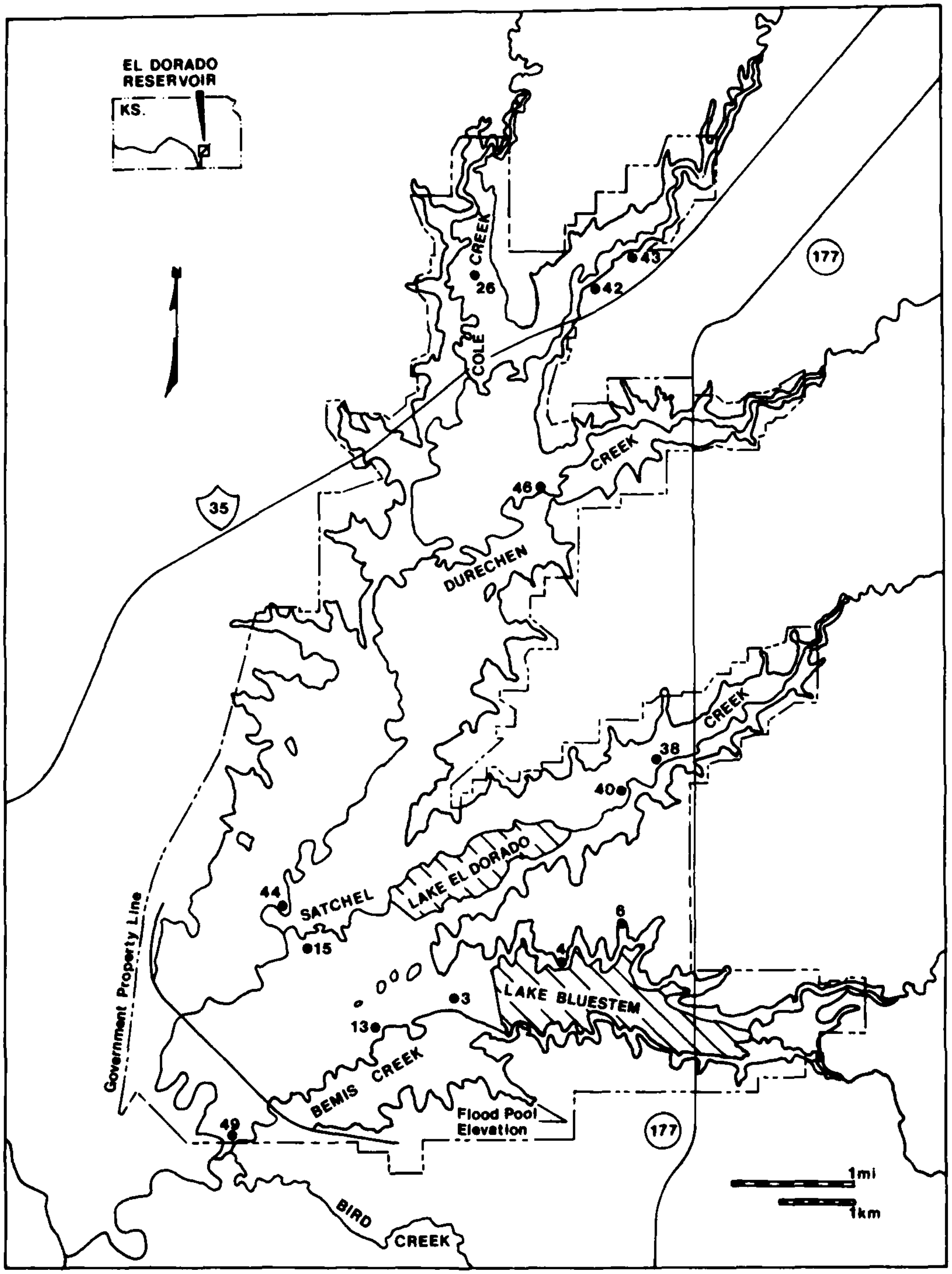

Figure 2.1. Location of find spots in the El Dorado Lake area (the '77-' prefix has been omitted).

77-3

This find spot is in Bemis Creek valley, approximately 0.5 km. west of the Lake Bluestem dam and 0.25 km. north of Bemis Creek. Dam construction activities changed the course of Bemis Creek to the south. Therefore, the creek probably flowed closer to the find spot than it does now. The surface collection consists of one fragmentary biface, six flake fragments, and six pieces of chert that may have been deposited by modern road construction activity or natural causes. Four flake fragments are pink or red indicating thermal treatment. All collected material is Florence chert. An auger test was made to a depth of 40 cm. No cultural materials were recovered; no indications of a buried cultural deposit were observed.

77-4

The find spot is located 100 m. north of Lake Bluestem and one km. east of Lake Bluestem dam in an upland prairie vegetational context. It is about 0.5 km. north of the former channel of Bemis Creek. Surface collected material includes one proximal flake fragment, six pieces of naturally occurring chert, and two turtle carapace fragments that are probably modern. The flake fragment, made of local chert, is the only definite prehistoric artifact.

77-6

This find was 200 m. north of Lake Bluestem and two km. northeast of the Lake Bluestem dam. It is in an upland prairie context, just to the east of a north-south trending intermittent stream which flows into Lake Bluestem. The locus is 1.25 km. north of the former channel of Bemis Creek. Prehistoric material consists of one flake and one flake fragment, both of Florence chert. Historic materials collected include one glass and one crockery sherd, a piece of tin, and a mule shoe.

77-13

This find spot is 200 m. west of Foster Cemetery, on a construction road. Bemis Creek flows 0.5 km. to the southeast at its closest point to the find spot. The single artifact collected is a large flake (7.97 cm. in length) with five dorsal ridges. Although the flake was recovered from a roadbed in a construction area, it could not have been produced by mechanical actions on naturally occurring chert. However, it is possible that it was transported to the area with the gravel used to make the road.

77-15

Materials were recovered from an area 300 m. east of the Walnut River and 200 m. south of Satchel Creek. This is 400 m. south of their confluence and 250 m. south of 14BU57. A river meander scar is about 200 m. west of the find spot, but any relationships between the two are unknown. One heat treated biface of Foraker chert, five flakes, a piece of shatter, and burned and unburned limestone were recovered. The area was field checked after the original surface collection was made in an effort to recover additional data concerning the nature of the finds. No additional cultural materials were found. The find spot may be related to 14BU57, but this conjecture is based solely on their spatial proximity.

77-26

Find spot 77-26 is located along Cole Creek, 1.3 km. north of its confluence with the Walnut. An intermittent creek flows to the north of the area. Seven flakes (two heat treated), one heat treated marginally retouched flake, and one broken biface were recovered. All are made of locally occurring cherts. These materials were recovered over an area of several hectares. Therefore, they may not all be associated.

77-38

This find is located along Satchel Creek, 1.2 km. east of Lake El Dorado and just west of an intermittent creek. Artifacts consist of a heat treated biface midsection and one flake. Both are of Florence chert. Six crockery and four glass sherds were also found that are undoubtedly associated with a group of farm buildings a few hundred meters away. The prehistoric material was recovered between an east-west trending meander scar to the south and a river terrace edge to the north.

77-40

Cultural materials were recovered approximately 200 m. north of Satchel Creek and about 0.5 km. northeast of the upper end of Lake El Dorado. This find spot is 0.7 km. southwest of 77-38. Four flakes of definite human manufacture were recovered. Three are of local chert and one is similar in appearance to a white chert that occurs in Chase County, to the north. It is also similar to the description given by Wedel (1959:480-81) of material collected from the Chase County quarries (14CS2 and 14CS3). However, this does not preclude the possibility of its occurrence locally. The field in which the find spot is located is covered

with chert gravel and cobbles. These are unmodified and appear to occur there naturally.

77-42

This find spot is located along the Walnut, two km. northeast of its confluence with Cole Creek. It is on a small limestone shelf, 12 vertical and 25 horizontal meters from the Walnut. This is in an upland prairie vegetational context, at the edge of the gallery forest and at the base of a prominent bluff. All artifacts were recovered from a 250 m^2 area. Ten flakes, some of which are thermally treated, one core fragment, one piece of raw material, and two pieces of chert and one piece of quartzite gravel were recovered. Florence, Foraker, and white chert are the raw materials present. Two auger tests were made on the limestone shelf and one was made a few meters up the bluff slope. The soil is only about five cm. thick and no indications of a structured deposit were present. The area was field checked after its initial discovery and no cultural materials were observed. The deposit matrix seems to be eroded away. For these reasons the area was given find spot status.

77-43

This find is 0.6 km. up river from 77-42. It is located in the present gallery forest-upland prairie ecotone, about 300 m. from the Walnut. An intermittent creek flows to the east of the find spot; a few flakes were found on the west bank of this draw. An inventory of artifacts follows: six flakes (one heat treated), one piece of heat treated shatter, and the distal end of an end scraper. All are made of locally occurring cherts. The artifacts were collected from a 500 m^2 area. An auger test was placed at the center of the artifact distribution to try to determine if a subsurface deposit was present. The soil was a consistent very dark grayish brown (10YR 3/2-moist) humic loam to a depth of 30 cm. Limestone bedrock was encountered at this level. The ped structure was visible to the surface, indicating the soil had not been recently disturbed. No indications of a subsurface cultural deposit were observed. The area was field checked after the initial survey, no additional artifacts were recovered.

77-44

This find spot is in a deep loop on the west side of the Walnut River across from 14BU4. Artifacts recovered consist of nine flake fragments (six heat treated), one broken river cobble, and a piece of chert gravel. All artifacts are made of local chert.

77-46

This find is located along the right (north) bank of Durechen Creek on the inside of a small loop, 1.5 km. northeast of its confluence with the Walnut. It is 200 m. south of 14BU98 and may be associated with it. A large erosional feature (possibly a meander scar) separates the two, but it is not presently known if the distribution in surficial debris is a result of the intervening area eroding away or not. For this reason, the two are treated separately. The surface collection is made up of seven flake fragments (two heat treated), one fragmentary heat treated biface, one heat treated chunk, a core, and a lead bullet. All prehistoric artifacts are made from local cherts.

77-49

This is an isolated flake recovered from the edge of a field along the right (west) bank of Bemis Creek, 0.8 km. north of its confluence with the Walnut. The find is 200 m. south of the El Dorado Lake dam, at the edge of construction. Therefore, its location may be due to recent construction activities.

Archeological Sites

Archeological sites discussed in the following paragraphs are those that were first recorded during the 1977 site reconnaissance. Cultural affiliations given are based on artifact styles indicative of broad cultural traditions. Comparative data are taken only from the project area. The exact meanings of stylistic similarities are not known; therefore, no direct connections are implied by the comparisons. Lithic collections are briefly summarized in terms of technological classes; definitions can be found in Leaf (Chapter 4, this volume). Locations of archeological sites in the project area are illustrated in Figure 2.2.

14BU82

The site is on the right (west) side of the Walnut River, just east of a southward flowing intermittent creek (Fig. 2.2). Surface scatter covers one ha. Projectile point styles indicate that Woodland, Plains Village, and possibly Archaic components might be present. The site was test excavated in 1977 and is discussed in detail by Leaf (Chapter 4, this volume).

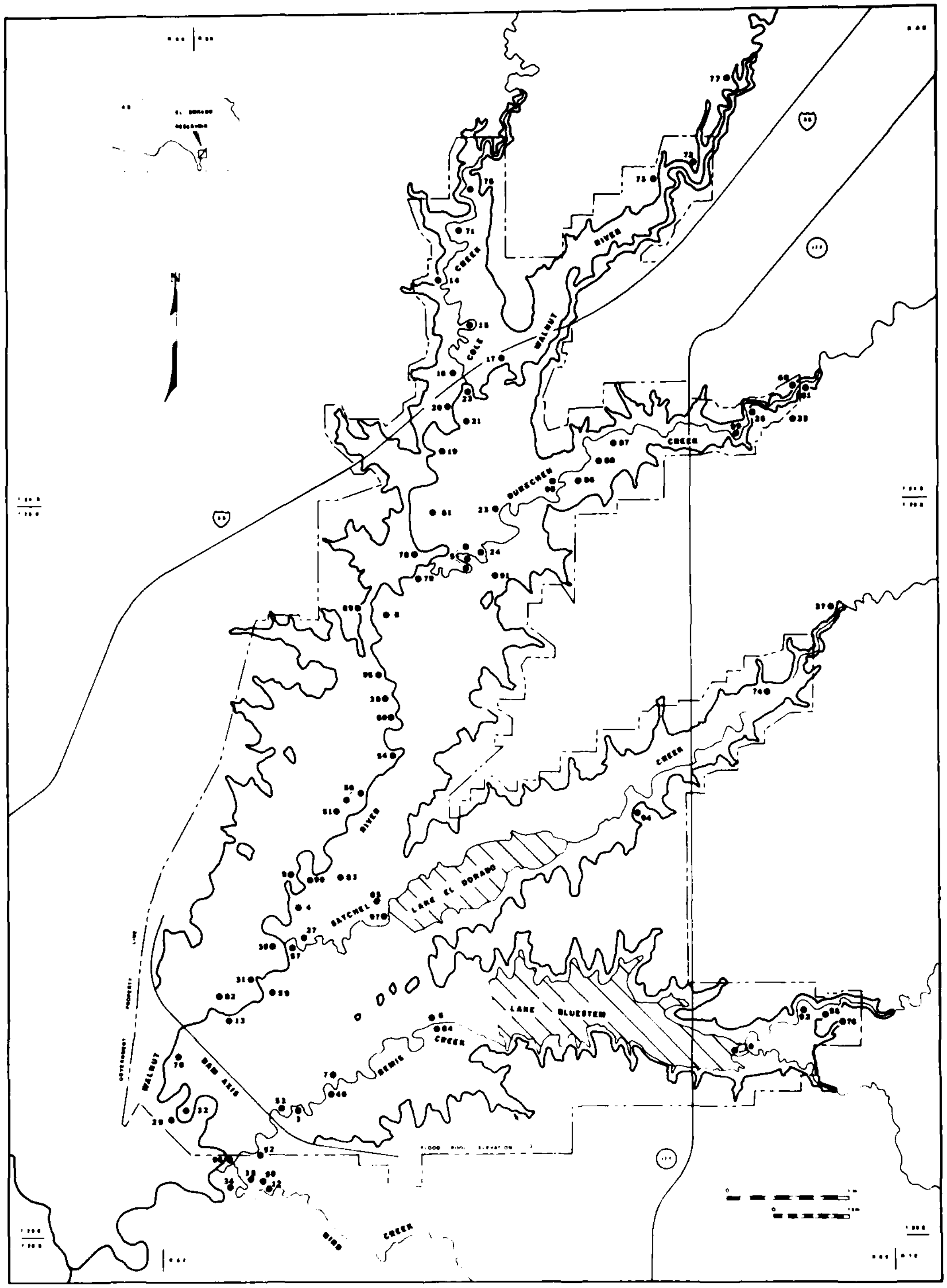

Figure 2.2. Location of archeological sites in the El Dorado Lake area. Site numbers are prefaced by state and county designations, e.g., 14BU9.

14BU83

The site is located on a terrace along the east side of the Walnut River, 1.1 km. above its confluence with Satchel Creek (Fig. 2.2). Although the surface scatter is along the Walnut, it extends to within 300 m. of Satchel Creek. There are five other sites in close proximity to 14BU83, between Satchel Creek and the Walnut.

Surficial debris covers approximately six ha. This area covers a distance of about 100 m. along the Walnut, but becomes 150 m. wide and extends 400 m. away from the river. Surficial artifact density was generally light. However, most artifacts were collected along a farm road where ground surface visibility was better than in the surrounding milo field. Therefore, it is likely that the restricted visibility in the field resulted in fewer artifacts being observed there.

The grab surface collection is made up of bifaces, unifaces, flakes, and unworked stone, bone and shell. Numerous flakes are present, many of which are heat treated. Unworked stone consists of weathered chert and burned limestone. Three end scrapers, all manufactured from flake blanks were recovered. Six bifaces were found, two of which are projectile point fragments.

The broken points are the only diagnostic artifacts present. One is the blade portion of a small, triangular, corner-notched point that is broken at the notches. Only the stem and bottom half of the blade are present on the other point. The stem is parallel-sided with a concave base (Fig. 2.3b). The first point style is usually associated with Woodland occupations and the second with Late Archaic and Woodland sites.

Most chipped stone artifacts were manufactured from cherts known to occur in the Flint Hills. Foraker and Florence cherts are the predominant kinds present. Foraker chert is known to have been quarried at the Maple City Quarry (14CO5), Cowley County, Kansas, 75 km. to the south of El Dorado (Wedel 1959: 476-480). An outcrop of Florence chert was discovered along Satchel Creek during site reconnaissance. Chert ranging from tan to gray is present in limestone outcrops along Bird Creek, just to the south of the project area (Bradley 1973:24-5). A minority of the cherts represented are of unknown specific origin, but probably occur in the Flint Hills.

Only one piece of exotic material is present, this is an end scraper made of Alibates chert. The specimen is marked by red, white, and white-blue banding and compares favorably with descriptions given by Bryan (1950:14) and Shaeffer (1958:189-91) for material from the Alibates quarry in Texas. Other chert beds in western Texas and eastern New Mexico contain material that falls within the range of red and white, and blue and white Alibates chert. These are easily confused with only visual inspection (Green and Kelly 1959:413-14). However, even if the chert is not from the Alibates quarry, it is of nonlocal origin.

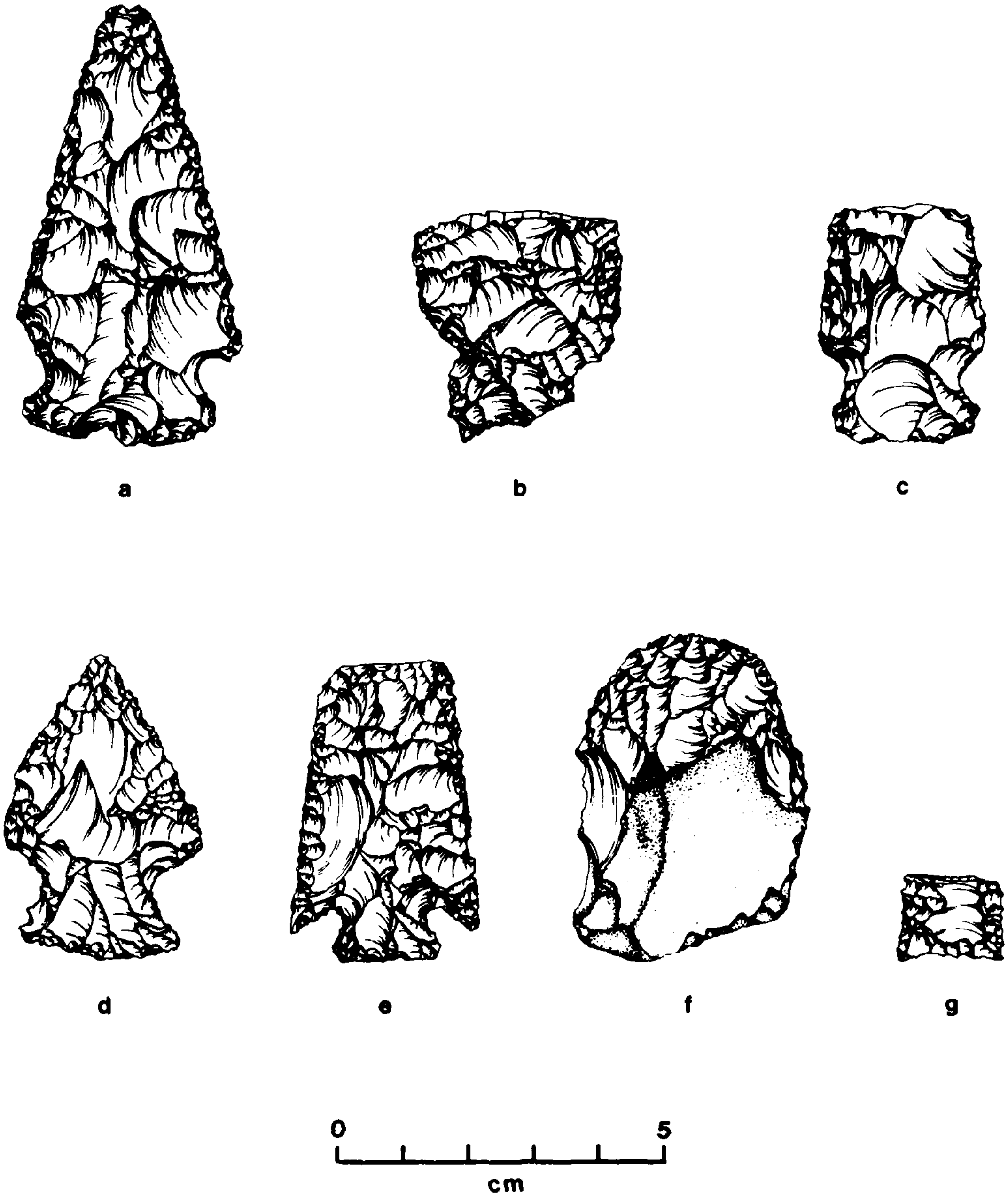

Figure 2.3. Chipped stone artifacts from the El Dorado Lake area: (a) projectile point, 14BU85 (A5002577-323); (b) projectile point, 14BU83 (A5001477-1); (c, d, e) projectile points, 14BU86 (A5002877-362, A5002877-359, A5002877-360); (f) end scraper, 14BU88 (A5002977-48); (g) projectile point, 14BU87 (A5003077-79).

There is only a small amount of information present on which to base interpretations. However, it is inferred that the site may have been a Woodland village. Both projectile points are of styles associated with Woodland occupations, although one is also associated with the Late Archaic. No ceramics were recovered which might reinforce the supposition of cultural affiliation. Ceramics are few in number in surface collections from most other Woodland sites in the project area. This is no doubt due to perceptive difficulties caused by the color and texture similarities between sherds and the ground. The size of the site (6 ha.) and diversity of technological artifact classes support the supposition that the site represents more than an ephemeral occupation. However, given the tenuous nature of the data, it is possible that a Late Archaic component is also represented.

14BU84

The site is 30 m. south of Bemis Creek and 0.9 km. west of Lake Bluestem dam (Fig. 2.2). This appears to be just west of an area affected by channel modification from the construction of Lake Bluestem. 14BU6 is directly across the creek.

The site is extremely small, covering only a 2,000 m^2 area. It is located in a field at the edge of the present treeline, on the first terrace above Bemis Creek. Surface debris is sparse, making the size estimate tenuous. There is a large meander scar 150 m. to the west of the site, marked by a dense chert nodule deposit in a shallow linear depression. Chert nodules are present throughout the immediate area, though not as concentrated as in the meander scar. It is assumed these nodules are not cultural, but present due to natural causes. There is a large hole, 2 m. deep, between the observed surface scatter and Bemis Creek. No cultural materials were found eroding out of the sides of the pit, indicating the site does not extend this far north.

The surface collection is made up of chipped stone, limestone, and chert gravel. The chipped stone assemblage consists of flakes, chunks, shatter, cores, a biface fragment, and the distal end of a projectile point. Eight flakes show evidence of possible utilization in the form of step fracturing. Some of the chert is heat treated. All chert raw material classes represented are found in the Flint Hills. Florence chert makes up most of the collection, although Flint Hills light gray and Foraker cherts are present. Unworked stone includes burned and unburned limestone, and chert gravel. Additional unburned limestone was present on the site, but was not collected.

The projectile point is too fragmentary to be diagnostic. A brief occupation by a small group is inferred from the small site size and sparse surface scatter. Tool manufacture is inferred from the presence of cores, chunks, and shatter.

14BU85

The site is situated on a terrace above Satchel Creek. Surface scatter is concentrated about 100 m. northwest of the Lake El Dorado spillway (Fig. 2.2). This was 200 to 250 m. from the creek course at the time of the government land survey (1857). The site is between 14BU83 and 14BU97.

The site covers approximately four ha., with artifact distribution predominantly above the river terrace (1330 ft. m.s.l.). Artifact density is relatively high. At the time of field reconnaissance, the site was situated almost entirely in an immature milo field, resulting in good visibility. A small portion of occupational debris extends into a grass covered pasture. Visibility was poor there, making site boundaries difficult to determine.

The surface collection consists of chipped stone, and unworked stone and bone. Unworked stone is represented by chert gravel, two pieces of burned limestone, and three pieces of raw material. The latter group is made up of small, patinated river cobbles which are within the size range of retouched tools recovered.

The chipped stone assemblage is marked by a plethora of unifacially retouched tools; 56 were collected. All are manufactured on flake blanks and fall into the morphological groups of end and side scrapers, unifacial knives, notches, and marginally retouched flakes. Only five of these are heat treated. In addition, flakes, chunks, cores, a resharpening flake, three broken bifaces, and a large corner-notched point were recovered (Fig. 2.3a). Many flake blanks show macroscopic signs of utilization in the form of step fracturing. However, a microscopic examination is necessary to distinguish step fracturing and edge rounding due to use from that caused by the multitude of other factors surface artifacts are subjected to.

A wide variety of cherts is present in the collection. Florence, light-gray, Foraker, Winterset, and Westerville cherts are represented. The projectile point is made from Westerville chert. The closest possible natural occurrence of Westerville and Winterset cherts is in the Westerville and Winterset limestone members of the Kansas City Group, 100 km. to the east of El Dorado (Reid 1978:70-72). The availability and exact locations of these cherts in that area are unknown. However, these cherts occur extensively in the Kansas City area.

The single diagnostic point is similar to those from Woodland sites. It is morphologically similar to the straight-sided, large corner-notched points recovered from the Snyder site (14BU9) which were associated with the Woodland component (Grosser 1970:57-8; Figure 6). The wide variety of morphological tool groups may indicate a concomitantly varied array of activities. Chert may have been thermally altered at the site as inferred from the presence of potlids. Tool manufacture and maintenance are inferred from the presence of cores, chunks, and a resharpening flake. The relatively

large surface area, high density of debris, and large number of tool groups indicate the site may have been a Woodland village.

14BU86

The site is on the left (south) side of Durechen Creek, 2.2 km. from its confluence with the Walnut River (Fig. 2.2). 14BU88 is directly to the northeast and 14BU98 is across the creek.

The site covers three ha. and consists of two concentrations, one of historic and one of prehistoric artifacts. Prehistoric materials are located in the northern portion of the site and extend to the creek bank. The southern part of the site is marked by a heavy concentration of historic materials. A creek meander scar curves through the area of prehistoric surface scatter, indicating the creek probably meandered through the site after the period of occupation. Although 14BU86 and 14BU88 are close to each other, it was determined that they represented distinct archeological sites. Ground surface visibility was excellent, making surface scatter distributions easily delimited. There is a definite break between the surface distributions of the two sites and diagnostic artifacts indicate different temporal periods are represented.

Indications of recent collector activities were noted at the site. Fresh car tire tracks and footprints were observed in conjunction with several collector piles. These consist of debitage picked up with other artifacts of popular interest, but then discarded at one location with the specimens of interest being removed.

The surface collection is large, consisting of 985 specimens. Chipped stone, worked and unworked limestone, bone, shell, raw material, and historic artifacts were collected. Four chert nodules were recovered that have one or two small flakes struck off, possibly representing tested raw materials. Two quartzite cobbles were found exhibiting heavy battering, denoting they probably functioned as hammerstones. These are certainly of nonlocal origin as the crystalline basement rocks in the El Dorado area are almost 1000 m. below ground surface (Fath 1921:26, 31-6).

Thirty-three bifaces were recovered, only four of which are complete. Two of these exhibit heat discoloration. Several interesting specimens are present which are worthy of individual description. Two small chert river cobbles have been bifacially retouched to produce working edges (the specimens measure 5.3 x 4.2 x 2.0 cm. and 4.7 x 3.8 x 2.0 cm.). This is direct evidence for small cobble utilization in tool production. One complete and five fragmentary projectile points were collected. Two distal fragments are undiagnostic, however, one exhibits an impact fracture. Three basal fragments are present, one is corner-notched (Fig. 2.3e), the other two side-notched (Fig. 2.3c). The

complete point is side-notched (Fig. 2.3d). The original blade morphology of this specimen appears to have been modified by resharpening. All these point forms have been associated with ceramics in the reservoir area (Grosser 1977; Fulmer 1977). Westerville, Florence, Flint Hills light gray, and Foraker cherts are represented.

Fifty unifaces were recovered from the site. These include side scrapers, notches, and marginally retouched flakes. They were manufactured from three blank types: chert river cobbles, tabloids, and flakes. Four of the specimens are thermally discolored. Unifaces were made from Florence, light gray, Foraker and a few miscellaneous cherts.

The remainder of the chipped stone assemblage is made up of cores, flakes, chunks, and shatter. Twenty-one cores or core fragments are present; they are polymorphous and discoidal cores, made on tabloids and river cobbles. Two cores are heat treated. Foraker, Flint Hills light gray, and Florence cherts are represented. The numerous complete and broken flakes are of the same chert classes, a few of them are heat treated. Seven resharpening flakes were also recovered.

Bone, mussel shell, and one piece of worked limestone were found. The worked limestone has an oval cross section and narrows to a point at one end with a smooth and regular surface. It is not known whether it was shaped in this manner through manufacture or use.

Eighteen crockery sherds, 12 glass sherds, and one piece of metal were collected from the southwest portion of the site. This may represent the location of the Osborne log cabin. The cabin was built ca. 1850 and was one of the first buildings constructed in Butler County (Madge Jones, Butler County Historical Society, personal communication).

The site appears to be a village; diagnostic artifact styles indicate a Woodland affiliation. No ceramics were recovered, but this problem was discussed above (see 14BU83). Numerous retouched tools are present and may represent many different activities. Tool maintenance and manufacture are inferred from the presence of cores, hammerstones, a few bifaces that may be tool blanks, raw material, resharpening flakes, chunks and shatter. The site is large and artifacts were abundant, supporting the tentative interpretation that this represents a village. An historic occupation which might represent the initial Euro-American settlement of the region is also present.

14BU87

The site is situated on the left (south) side of Durechen Creek, 2.9 km. from its confluence with the Walnut (Fig. 2.2). An intermittent creek flows to the east of the site and marks the limit of surface scatter on that side. Site 14BU88 is just to the south.

The heaviest concentration of surficial debris is on the slopes and bottom of a meander scar. The meander scar boundaries are roughly coincident with the 1340 foot contour line of the U.S.G.S. quadrangle. Surface scatter extends beyond this heavy concentration, covering approximately three ha. between the intermittent stream and Durechen Creek. Surficial limits of 14BU87 and 14BU88 are less than 50 m. apart. Ground surface visibility was near 100%, so the spatial distribution was easy to determine. Diagnostic artifacts indicate a temporal distinction is also present. Therefore, it was decided that two sites are represented.

The collection is made up of chipped stone, raw material, unworked bone, limestone, and weathered chert. The lithic assemblage consists of unifaces, bifaces, cores, and debitage. There are 11 bifaces, one of which is the proximal end of a small, isosceles triangular point (Fig. 2.3g). Another interesting specimen is a small river cobble with one bifacially retouched edge. There are 15 unifaces, including end and side scrapers and marginally retouched flakes. Nine of the retouched tools are heat treated. River cobbles and tabloids were used for cores, two are heat treated. Sixteen of the numerous flakes show macroscopic edge damage which may be indicative of utilization. The single piece of unmodified raw material is a large (921.9 g.), heavily patinated, river cobble of Florence chert. The chipped stone assemblage was manufactured from Florence, light gray, and Foraker cherts.

The single diagnostic artifact is the triangular point. In the project area these are associated with shell tempered ceramics (Fulmer 1977:47) and a corrected radiocarbon date of A.D. 1267 ± 90 years from 14BU71 (Fulmer 1977:79). A Plains Village cultural affiliation for 14BU87 is inferred from these associations. Artifact density was greatest on the slopes and bottom of the meander scar. This might be caused by several factors. Most of the cultural horizon is possibly below the plowzone, and as the creek cut through the site, it exposed the deposit. Surficial artifact density is greatest in the old channel because the deposit is eroding out there. Alternatively, there could be a build up of artifacts in the meander because material is washing into the depression. If there is a subsurface deposit of considerable density, the site could represent a late village occupation. If not, it might only be a seasonal encampment.

14BU88

14BU88 is on the left (south) side of Durechen Creek, 2.5 km. from its confluence with the Walnut River, directly between 14BU86 and 14BU87 (Fig. 2.2). The spatial distinction of these sites has been discussed above.

The site is on a terrace and covers about three ha. Surface scatter was light, with no areas of high artifact density. However, the site had been recently vandalized at the time of inves-

tigation and, therefore, determinations based on surface scatter will obviously be affected. Several potholes had been dug, no doubt in search of artifacts. Piles of debitage were also observed. As in the case of 14BU86, collector piles represent artifacts that were not of interest to the vandals and were discarded.

The surface collection consists of chipped stone, bone, and unworked stone. The latter group is made up of burned and unburned limestone, weathered chert, and unworked chert. Most of the unworked chert is small river gravel which appears to be too small for use in tool production. However, three of the larger specimens are within the size range of retouched cobbles from other sites and are potential raw materials. One well rounded chert cobble is battered on an edge, indicating it may have been used as a hammerstone.

The chipped stone assemblage consists of retouched tools, numerous flakes, cores, chunks, and shatter. Nineteen bifaces were recovered, seven of which were heat treated. Two small, corner-notched projectile points are included in the collection. In addition, one large, heat treated, corner-notched point was found. Although the distal end is broken off the latter, the remaining portion is still 7.3 cm. long. A small, heat treated, triangular biface with a convex base might have been a point preform. Most of the remaining bifaces are thin and probably functioned in light-duty tasks. One is larger and thicker, but has no apparent working edge. Another is lanceolate in form with an equilateral triangular cross section. A bifacial end scraper manufactured on a small cobble is present (Fig. 2.3f). Bifaces were manufactured from Florence, Foraker, and an unknown orange chert.

Twenty-three complete and broken unifaces were recovered. These are morphological scrapers and marginally retouched flakes. Only five are heat treated. With one exception, all unifaces were made on flake blanks. The unique specimen is an exhausted river cobble core with a scraper edge on it. Raw materials represented are light gray, Florence, and Foraker cherts.

The rest of the chipped stone assemblage is made up of cores, chunks, shatter, and hundreds of flakes. Flakes vary from large decortication flakes to small resharpening chips. Many of these specimens are heat treated and/or utilized. Thirty cores and core fragments were recovered. They are polymorphous and discoidal cores made on river cobbles and tabloids; four are heat treated. The cores are made from Florence, light gray, Foraker, and miscellaneous cherts.

One of the small, corner-notched points is of a style associated with Woodland occupations (Fig. 2.4f). The large, corner-notched point (Fig. 2.4a) and the point made of orange chert (Fig. 2.4e) are associated with Woodland and Late Archaic sites. Therefore, it is possible that the site is horizontally stratified.

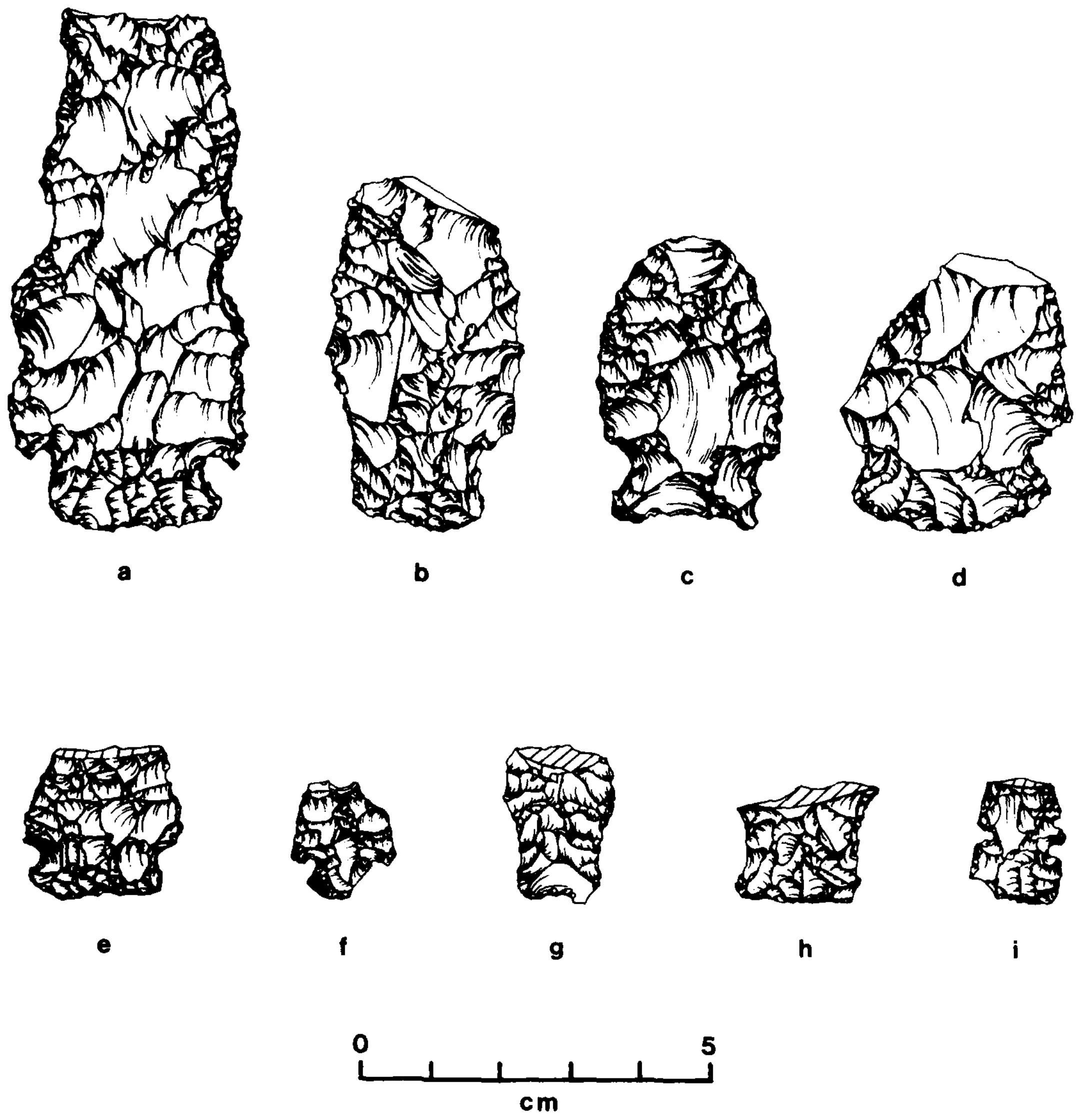

Figure 2.4. Projectile points from the El Dorado Lake area: (a) 14BU88 (A5002977-291); (b, c, d) 14BU91 (A5005677-4, A5005677-26, A5005677-8); (e, f) 14BU88 (A5002977-586, A5002977-585); (g, h) 14BU89 (A5005277-11, A5005277-142); (i) 14BU90 (A5006177-138).

Raw material reduction and tool manufacture and maintenance are inferred from the presence of cores, large decortication flakes, chunks, shatter, a hammerstone, and resharpening chips. The site is relatively large and the variety of retouched tools and other artifacts might indicate that a diversity of activities was carried out there. The site may be a small Woodland village. The possibility is present that a Late Archaic occupation may also be represented.

14BU89

The site is located on a bluff top, overlooking the Walnut River, on the west side, about one km. south of Durechen Creek (Fig. 2.2). A wooded draw with intermittent flowing water is to the west and south.

This is one of three sites in an upland geographical context in the project area. Surficial debris was observed in a farm road where the prairie vegetation had been killed. All material was recovered from this road. Although the surrounding area was thoroughly searched, vegetation cover was so heavy no cultural materials could be found. This makes exact delimitation of site surface boundaries impossible. However, material was collected for 300 m. along the farm road. Observable surface scatter is 150 horizontal and 16 vertical meters from the Walnut. There is a very steep bank, about seven m. high between the site and the Walnut.

The site cannot have deeply buried deposits, as the soils are relatively thin in this upland locality. An open pipeline trench, which ran 200 m. to the northwest, was present during investigations, and the stratigraphy of the trench was mapped. Parent limestone occurred from depths of 1.1 to 1.5 m. below ground surface. At present, it is a reasonable assumption to extrapolate these figures to the site area, which is on the same bluff a short distance away.

The only artifacts associated with the aboriginal occupation are chipped stone. The collection is small, but this is probably due to restricted visibility. The assemblage consists of retouched tools, flakes, chunks, shatter, cores, and one piece of raw material. Most of the artifacts are broken, a result of their location in a road. Two polymorphous cores were recovered, both of local chert. One is a river cobble and the other is of unknown raw material form.

Retouched tools include four unifaces and ten bifaces, all fragmentary. The distal portion of an end scraper and three fragments without distinct working edges comprise the unifaces. Three projectile point bases are present. One is a stemmed point with gently incurvate lateral stem margins and an incurvate base (Fig. 2.4g). Another has indented lateral basal margins and a straight base (Fig. 2.4h). The third is too fragmentary for morphological determinations. Retouched tools are made from Florence, light gray, and Foraker cherts.

The projectile points represent styles associated with Archaic sites. Stemmed points with concave bases are associated with radiocarbon dates of 1700 ± 140 B.C. and 2030 ± 100 B.C. at the Snyder site (Grosser 1977:63). Because visibility was restricted, the collection is small and site size and distribution are almost totally unknown. Therefore, interpretations as to the nature of the site are extremely tenuous. The site may have been a Late Archaic seasonal camp. Floodplain and upland resources would have been close. Alternatively, the bluff top offers a 360° vista of the surrounding prairie

and river bottoms. This would be an excellent spot to establish a hunting camp, in that faunal movements could easily be observed. These differing explanations cannot be resolved at present.

14BU90

14BU90 is at the opening of a deep loop of the Walnut on its east side. It is directly west of 14BU83 and north of 14BU4. The mouth of Satchel Creek is one km. to the south (Fig. 2.2).

Low density surface scatter was located in a milo field with good ground surface visibility. A northeast-southwest trending terrace delimits the eastern border of the site. The loop, to the west of the milo field, is forested, making determination of site boundaries difficult in that area. Surficial debris occurs below the terrace edge, as opposed to the usual situation where it is above the terrace. The site covers at least 1.5 ha., but extends an unknown distance into the gallery forest to the west.

Cultural materials recovered include a hammerstone, chipped stone, burned and unburned limestone, sandstone, a piece of worked, weathered chert, and a potsherd. The weathered chert is reddened, possibly from thermal alteration. One surface is extremely flat and smooth and is definitely due to human alteration. The piece is too small to make functional speculations meaningful. The hammerstone is a broken quartzite river cobble with battering on one surface. Quartzite does not outcrop in the project area, therefore, the single specimen must be of nonlocal origin. The sherd is a small, cord marked body fragment, tempered with indurated clay.

The chipped stone collection is made up of retouched tools, cores, flakes, chunks, and shatter. The single biface is a small, isosceles triangular point made of Florence chert. One lateral margin has two small notches, the other has one notch (Fig. 2.4i). The five unifaces show remarkable raw material variation. A side scraper is made of chert from the Alibates quarry area (Bryan 1950: 14; Shaeffer 1958:189-91) or other similar deposits in west Texas and eastern New Mexico (Green and Kelly 1959:413-14). A side scraper made of heat treated Westerville chert was also collected. The three remaining unifaces, two marginally retouched flakes and a small end scraper (Fig. 2.5d), are made from Foraker and a gray, tan, and white mottled chert of unknown origin. Five cores and core fragments are present. One is made of white and maroon mottled chert; this is Alibates or one of the similar exotic cherts. All chunks and shatter are heat treated. The cleavage surfaces are crazed and/or marked with potlid fractures. These features have also been observed on similar material from other sites. This presents the possibility that chunks and shatter can be produced by thermal cracking in addition to raw material reduction activities. Similar debris has been experimentally produced by subjecting chert to rapid temperature increases (Purdy 1975:135-36).

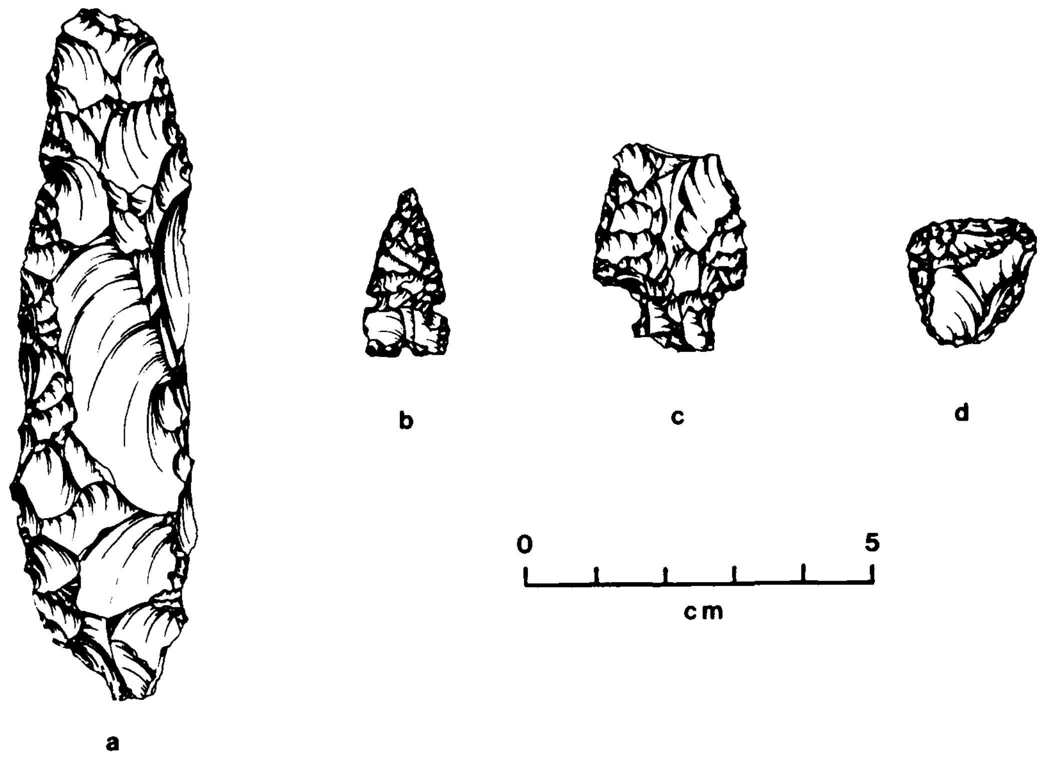

Figure 2.5. Chipped stone artifacts from the El Dorado Lake area: (a) lanceolate biface, 14BU98 (A5005577-3); (b, c) projectile points, 14BU98 (A5005577-2, A5005577-1); (d) end scraper, 14BU90 (A5006177-81).

The two diagnostic artifacts are the potsherd and projectile point. Small, isosceles triangular points with multiple side-notches are indicative of occupations postdating the Woodland period. The single sherd is not indicative of any particular ceramic period. Cord marked, indurated clay tempered sherds were recovered from 14BU71 and are associated with a corrected radiocarbon date of A.D. 1267 $\pm$ 90 years (Fulmer 1977:79). Similar sherds were also recovered from 14BU55 with associated dates of A.D. 1060 $\pm$ 60 and A.D. 980 $\pm$ 80 years (Fulmer 1977:41). Cord marked, indurated clay tempered ceramics have also been recovered from other Woodland sites in the area.

The nature of the site is difficult to determine due to restricted visibility in the woods to the west. The light surface scatter and small area implies an occupation of relatively brief duration. However, until the wooded area can be investigated more thoroughly, this interpretation is regarded as tenuous. The presence of exotic cherts indicates direct or indirect contacts with several different regions.

14BU91

The site is located on the west side of a small, intermittent stream which flows into Durechen Creek 200 m. to the northwest (Fig. 2.2). 14BU5, Area B, is located 0.5 km. down Durechen Creek; 14BU5, Areas A and C, and 14BU24 are across the creek.

All artifacts were recovered from a dish-shaped erosional feature which may be a meander scar. There is a slight, but abrupt rise to the southwest of the intermittent stream, after which there is a gradual downward slope where surface scatter was localized. The site appears to be small, covering only 4000 m^2, but surficial debris density was relatively heavy. Given that the site is located in an erosional feature, it is possible that cultural materials are eroding out of a buried deposit.

Recovered material includes chipped stone, faunal remains, and historic artifacts. Five pieces of unworked mussel shell and a *Terrapene* sp. carapace were collected. These materials may or may not be associated with the prehistoric occupation. Eleven sherds of historic crockery were recovered.

The chipped stone assemblage is made up of flakes, bifaces, unifaces, and chunks. Unifaces consist of four marginally retouched flakes and one broken end scraper. There are 29 bifaces in the collection, which vary from small light-duty tools, which may have functioned as cutting implements, to large thick tools which could have been used in heavy-duty activities. Thirteen bifaces have been heat treated. Six of the bifaces are projectile points, only two of which are complete. Four of the points are corner-notched, two with convex bases (Fig. 2.4d). These are associated with Woodland occupations in the area, although their temporal range extends to the Late Archaic elsewhere. The other two points are stemmed, one with expanding lateral stem margins and a straight base (Fig. 2.4b), the other with convex lateral and basal margins. The distal end of the latter point is marked by an impact fracture (Fig. 2.4c). Both of these point styles are associated with one of the Late Archaic occupations at 14BU9 (Grosser 1977:60-1). Raw material classes represented in the collection are Florence, light gray, Foraker, Westerville, and a few miscellaneous cherts.

The site may represent Late Archaic, or Woodland and Late Archaic occupations. The site is small, but artifact density is high. This may be a result of only a portion of the site being exposed by erosion, or it may be a small camp.

14BU94

The site is on a low bluff on the left (south) side of Satchel Creek, approximately 0.75 km. from the upper end of Lake El Dorado (Fig. 2.2).

The site is presently in an upland prairie physiognomic vegetative context. At the time of the General Land Office survey (1857), arboreal vegetation extended to the site's western limit, however, trees are no longer present. There is a steep, but traversable vertical drop of about nine m. from the edge of the bluff to the creek. The exact surficial distribution of cultural materials could not be established with any certainty due to extremely poor ground surface visibility. Artifacts were recovered only from places which had been cleared of vegetation cover by cattle in a 3000 m^2 area, which extended to within 40 m. of the creek.

The surface collection is small, consisting of chipped stone, a few pieces of burned limestone, and chert gravel. Limestone occurs naturally on the bluff top and, therefore, the burned specimens are not necessarily associated with the other cultural materials. With the exception of three pieces of shatter, two chunks, and one potlid, the chipped stone assemblage is made up entirely of flakes. Two of the 67 recovered flakes are utilized. Although the collection is small, three raw material classes are represented; Florence, light gray, and Foraker chert. Fifty-two of the 73 pieces of chert collected (71.2%) are thermally treated.

No diagnostic artifacts were recovered on which to base cultural affiliations. One possible interpretation as to site function is that it was a small chipping station. The presence of a potlid and a high percentage of heat treated flakes indicate that chert was thermally altered here. Of course, if this was a locus of flint knapping activities, one would expect to find broken preforms, artifacts abandoned due to technological errors, and cores or core nuclei. Therefore, this preliminary interpretation can be checked in the future.

14BU95

14BU95 is located at the confluence of an intermittent creek with the Walnut River (Fig. 2.2). Surface scatter is on a terrace along the west side of the river. The site is at the base of the bluff where 14BU89 is situated, which is one km. to the north.

Artifacts were recovered from a farm road and eroded areas of the river terrace that were clear of vegetation. The surrounding area was covered with vegetation making surface visibility poor. Cultural materials were recovered from a 5000 m^2 area, but restricted visibility made accurate size estimates impossible.

The collection includes chipped stone, a large mammal tooth, and small bone and shell fragments. The faunal material is all of probable modern origin. Chipped stone consists of flakes, two cores, chunks, shatter, and one small biface fragment. The latter specimen is possibly a projectile point barb fragment. The majority of the collection is Florence chert, although a few flakes of Foraker chert were recovered.

The lack of information concerning site size and distribution make interpretations difficult. If the site is not much larger than present surface indications show, it may be a small, ephemeral camp of unknown temporal placement.

14BU97

The site is located on the north side of Satchel Creek, just below the Lake El Dorado spillway. Site 14BU85 is 0.25 km. to the northwest (Fig. 2.2).

Surface scatter is located between State Highway 177 and the present course of Satchel Creek. It is highly probable that the roadbed passes over part of the site, or that road construction activities have destroyed part of the site. General Land Office survey notes record the creek as flowing slightly to the south of its present course. It appears that the eastern portion of the site was destroyed by rechanneling Satchel Creek. The area across the creek and road were surveyed to determine if any intact deposits remained in those locations. Results were negative, but vegetation cover was 100% making these observations tenuous. Site 14BU85 is nearby, but a spatial distinction was present. Therefore, since the only known relation between these two areas of surface scatter is spatial proximity, they are considered as two different sites. Site 14BU97 is situated at a favorite local fishing spot and is continuously visited by local residents, undoubtedly affecting the representativeness of the surface collection.

It could not be determined how much, if any, of a buried deposit remains intact. Surface debris was collected on top and just over the side of the creek bank. Soil probe tests to depths of one meter revealed no indications of a cultural horizon. Cultural material could either be eroding out of a sparse, buried deposit or over the edge of the bank from a surface deposit. Surface scatter covers an area of 300 m^2 along the creek bank. Artifact density was relatively heavy in a few areas at the bank edge, but was light away from the bank itself.

The collection consists entirely of lithics. One biface, one potlid, and 81 flakes or fragments thereof make up the assemblage; 76 of which (91.6%) are thermally discolored. The heat treated biface is made of Foraker chert, as are a few of the flakes. From what can be determined, the rest of the collection is Florence chert.

Because the site is partially, and probably almost completely, destroyed and is located in a current public use area, interpretations are difficult to make. It is possible that the site represents a chert heating and chipping locality, but this is speculative.

14BU98

The site is on a terrace above the right (north and west) bank of Durechen Creek two km. from the creek's confluence with the Walnut. Site 14BU86 is directly across the creek (Fig. 2.2).

Cultural debris is densely scattered on the north edge of an erosional feature which may be a meander scar, close to the creek. Surficial debris becomes less concentrated moving north, covering 0.5 ha. Although part of the site may have been destroyed, buried deposits do not appear to be washing out.

The collection consists of chipped stone, a hammerstone, and gravel. The hammerstone is a large, spherical chert river cobble that is heavily battered on one end. The chipped stone assemblage includes retouched tools, numerous flakes, resharpening chips, cores, chunks, and shatter. The three cores are small and are probably exhausted or nearly so. One is a river cobble, the other two are of indeterminate raw material form. Many pieces of chunks and shatter are thermally damaged river cobble fragments as evidenced by crazing, potlid fracturing, and/or discoloration. These specimens suggest the possibility that raw materials were thermally prepared and/or that river cobbles were used as hearthstones or for functions other than lithic tool production.

Four unifaces and seven bifaces were recovered. Two unifaces are manufactured on flake blanks, one is on a river cobble, and the remaining one is on a thin, plate-like tabloid. All have scraper edges. Two of the bifaces are projectile points. One is a heat treated, isosceles triangular point with side-notches about 1/3 of the distance from base to tip and a basal notch (Fig. 2.5b). The other is a midfragment of a stemmed point (Fig. 2.5c). One biface with a morphological scraper edge was manufactured on a thin tabloid of light gray chert and a lanceolate tool is made of Westerville chert (Fig. 2.5a). The rest of the lithic assemblage consists of Florence, light gray, Foraker, and a few miscellaneous cherts. One white quartz flake is also present.

The small, notched, triangular point is indicative of a Plains Village occupation. Stemmed points have been recovered from Woodland and Late Archaic sites in the area. Therefore, based only on the two points, the site could be multicomponent. Part of the site is apparently destroyed, making the nature of the site difficult to assess. However, manufacture and maintenance of tools are inferred from the presence of cores, a hammerstone, and resharpening chips. Find spot 77-46 is located 400 m. from this site, on the south side of the eroded area. It is possible that the two areas are part of the same site with the intervening area scoured out.

14BU99

The site is on the right (north) side of Durechen Creek, approxi-

mately four km. from its confluence with the Walnut (Fig. 2.2). Cultural materials were recovered from the inside of a small bend in the creek.

Visibility was poor, making site limits difficult to delimit. Artifact density appeared light, but this may be due to heavy vegetation cover. A meander scar, about two m. deep runs through the site. Some material was recovered from the slopes of the old creek channel.

The distal end of a projectile point, a piece of tested raw material, and some flakes were recovered. The tested raw material is a river-rolled tabloid of Florence chert with four small flakes struck from one platform. Negative flake scars indicate that the flakes were probably too small for use as tool blanks. The distal projectile point fragment, made of Florence chert, is too small to reconstruct the original tool outline. Raw material classes represented by flakes are Florence, light gray, and Foraker cherts.

The site's cultural affiliation could not be determined. It is possible that the site represents a small, briefly occupied camp.

SUMMARY AND CONCLUSIONS

The survey program accomplished Phase I goals with a relatively high degree of success. Two new sites in upland contexts were located, bringing the total number of upland occupations to three. One of the sites found during recent investigations is an Archaic occupation, the other two are unknown. The upland location of 14BU89 is unique among known Archaic sites in the project area.

Thirteen sites were found in river and creek valleys, a significant increase given the fact that these localities had been previously surveyed. Plains Village, Woodland, and possibly Archaic components are present on these sites. Two sites have Woodland and two have single component Plains Village affiliations. Possible multicomponent sites consist of two with Plains Village and either Woodland and/or Late Archaic, and three sites with either Woodland and/or Late Archaic components.

In addition to recording more sites, data were gathered concerning previously known sites. Tentative cultural affilations were determined for many sites which were unknown prior to Phase I work. Eleven multicomponent sites are now known. Twelve components appear to represent Plains Village tradition occupations, a notable increase over the two previously reported. The potential of investigations concerning the nature of these later occupations is obviously greatly enhanced. Sixty-six prehistoric sites are now known in the project area. In addition to the 12 Plains Village components, 27 Woodland, 7 Archaic, 9 sites with indeterminate Archaic or Woodland, and 24 unknown components are represented. Indeterminacy is a result of artifact styles that are associated with both Late Archaic and Woodland occupations.

Although 15 sites were recorded during 1977 site reconnaissance, it is hypothesized that more unrecorded occupations are present in the project area. Stretches remain along several water courses that have low site densities. Three upland sites are known, but this is not a large number compared with the number of known occupations in the valleys. It is felt that these conditions reflect survey biases, and not actual site location patterns.

The four main sources of survey bias are vegetation cover, local collector activities, site destruction, and site burial by natural depositional processes. Limitations imposed by ground surface visibility are exemplified by observed artifact distribution on the two upland sites, 14BU89 and 14BU94. Surficial debris could be seen only in areas cleared of plant cover by recent disturbances. No artifacts were recovered from the surrounding areas covered with prairie grasses. It is obvious that without the coincidental occurrence of cleared areas on these sites, they would not have been found. The implication of these observations is that more upland sites are present, but were not located due to 100% vegetation cover. This also illustrates how sites can be protected from indiscriminate public collecting by allowing them to become overgrown.

Collector activities also influenced survey results. Amateur collecting and pothunting were noted at two sites during the survey. The popularity of 14BU29 with local collectors was given as the reason that no artifacts were recovered from that site during a previous survey (Eoff and Johnson 1968:39). This was also the case during the 1977 survey and could have been caused by heavy vegetation cover and/or collector activities. Artifact collections made by amateurs were reported from most sites recorded in the initial survey of the area (Eoff and Johnson 1968).

Fulmer (1976, Figure 2) illustrates the locations of numerous areas purported by local collectors as being places where they had found artifacts. These could not be confirmed by Fulmer and, therefore, were not recorded as archeological sites. However, two of these are spatially coincident with two newly recorded sites, 14BU84 and 14BU94. Artifact samples from these sites are small and contain only a few retouched tools. This might be a reflection of bias introduced by amateur scavenging. Complete tools and, especially, diagnostic artifacts are the ones usually picked up by amateurs. This kind of selective artifact retrieval will obviously influence interpretations derived from later surface collections.

A third source of bias is site destruction. Large areas behind the dam have been dug up for use as dam fill. This has already destroyed six sites. In several cases only small surface collections remain on which to base interpretations. A considerable area along Bemis Creek is now a borrow pit. Four unconfirmed sites reported by local residents are located either in this borrow area or under the dam. We will never know if sites were present there or not. Lake Bluestem and Lake El Dorado also have created large water covered areas where sites cannot be found. Several sites have been partially destroyed by river and creek meandering. It is possible that some sites were completely destroyed by such natural occurrences.

The fourth source of bias is that introduced by depositional processes. Unless erosion happens to expose a deeply buried site we will probably never know of its existence. This is unfortunate in that buried occupations would probably be Archaic and older sites. An example of the fortunate exposure of an Archaic site by intermittent creek downcutting is 14BU25. Buried components can also be discovered via excavation if surface components are present. An example of this is 14BU9, where there are at least four buried cultural horizons.

Although these factors hamper site survey activities, some of them can be overcome. Vegetation cover changes continuously in most areas. As fields are plowed and crops are harvested, ground surface visibility improves. Even though sites may be heavily collected by amateurs, we can eventually locate them. It will be impossible to locate sites which might have been in areas destroyed by construction. Some deeply buried sites may never be found. To assume that all sites have been or ever will be found is to disregard limitations inherent in surface survey data. But, by keeping detailed records of vegetation cover it can be determined which areas of light and heavy ground cover do not contain sites. With these data, those areas actually free of surface sites can be accurately delimited.

The hypothesis that more sites are present in the project area is supported by several observations. Unexpected low site density areas were observed along the Walnut at the upper end of the flood pool, the middle reaches of Durechen Creek, and all of Satchel Creek. A proposed reason sites were not previously recorded in such areas was that the extant survey was weak or nonexistent. Given reasonable survey conditions, it was predicted sites would be found (Leaf 1976a: 40). Five sites were recorded in the middle reaches of Durechen Creek and two were found in the Satchel Creek valley. However, the upper areas of the Walnut and most of Satchel Creek are still almost barren of recorded sites. The areas of remaining low site density are coincident with areas which were heavily vegetated during the survey, while stretches which were relatively clear of vegetation correspond with locations of new sites. It is inferred that sites are present in low density areas and can be located as vegetation cover changes.

Additional support is provided by the presence of archeological find spots in low density areas. It is possible that continued monitoring of several find spots in poor visibility areas will prove these to be archeological sites. In addition, cooperative local amateurs reported many site locations that have not been confirmed (Fulmer 1976, Figure 2). Some of these areas may also represent unrecorded sites.

It was recommended in the research design that creek and river banks be searched for buried sites (Leaf 1976a:41). Cutbank examination was not carried out systematically for several reasons. Vegetation and leaf litter were so heavy in most of these areas that ground surface visibility was almost 0%. Banks adjacent to known sites thought to be eroding into the river were checked, but no

cultural materials were observed. Therefore it was decided that a systematic survey of these areas would be inefficient and unproductive. However, those banks which were clear of vegetation were examined. The efficacy of bank survey was reevaluated in the fall, after the vegetation had died. However, the ground was still covered with leaf litter and compost.

Although only three upland sites are currently known, they are located in similar geographic situations. The three sites, 14BU52, 14BU89, and 14BU94, are presently in a prairie ecozone, as they were during the GLO survey of 1857. Whether or not these occupations were in the upland prairie aboriginally is currently unknown. The sites are on bluff tops, nine to 20 m. above a creek or river in elevation, but within 150 horizontal meters of those water sources. The bluffs offer an excellent view of the surrounding prairie and river valleys. It is possible that these were temporary camps with their locations chosen because of proximity to riparian and sylvan resources and the view of the upland prairie for hunting. If this is not a fortuitous pattern, other sites should be located in similar geographical situations.

Remaining areas of low site density that had poor ground surface visibility, and localities that fit the pattern of observed upland site location, should be monitored in the future. In addition to the low site density areas mentioned above, the east side of the Walnut River from one km. north of Satchel Creek to Durechen Creek is devoid of recorded sites. This area had poor ground surface visibility and should also be monitored. Additional work will lessen the effects of survey biases discussed above and thus make locational analyses more meaningful.

CHAPTER 3

A MANAGEMENT PLAN FOR THE PREHISTORIC CULTURAL RESOURCES OF EL DORADO LAKE

Matthew J. Root

INTRODUCTION

When El Dorado Lake is at multipurpose pool elevation, 24 known archeological sites will be partially or wholly above water. These sites are the subject of the proposed cultural resource management plan. Their locations, along with other known sites in the project area, are illustrated in Figure 2.2. A number of these sites will be impacted, in varying degrees, by lake level fluctuations between multipurpose and flood pool elevations. Still others are located below the dam, and thus are not subject to inundation. However, they may be affected by construction of public use areas and their subsequent utilization. The purpose of this chapter is to outline possible and probable effects of federal project activities on these cultural resources, and present a plan to preserve and protect potential information contained therein.

IMPACTS ON CULTURAL RESOURCES

Sources of potential deleterious impacts caused by construction of El Dorado Lake are summarized in Table 3.1. Sites impacted by multipurpose (1339 ft. a.m.s.l.) and flood pools (1347.5 ft. a.m.s.l.) will be completely or partially under water when the lake is at those levels. Sites completely inundated by the multipurpose pool will be the subject of test and/or salvage excavations to mitigate the destructive effects of lake construction. As those sites will not be accessible when the lake is in an operational mode, they are not included in the management plan. Sites between multipurpose and flood pool elevations will be tested in an effort to accurately assess their relative research potential. However, they will be partially or completely exposed at various times and should be protected as much as possible. Other sites that will not be flooded will be disturbed by construction or vandalism. Specific adverse effects are outlined below.

The effects of inundation are currently poorly understood. However, it has been pointed out that inundation does not totally preserve archeological deposits. On the other hand, not all flooded sites are so thoroughly destroyed that they become worthless for investigatory purposes (Garrison 1977:151). In some cases, submerged sites are subject to erosion by underwater currents. This type of

Table 3.1. Summary of impacts on the prehistoric cultural resources of El Dorado Lake.

Site	Multipurpose Pool	Flood Pool	Other Construction	Vandalism
14BU3	x	-	x	-
14BU4	x	-	-	-
14BU5	x	-	-	-
14BU6	x	-	-	-
14BU7	x	-	x	-
14BU8	x	-	-	-
14BU9	x	-	-	-
14BU10	x	x	-	x
14BU13	-	-	x	-
14BU14	x	x	-	x
14BU15	x	-	-	-
14BU16	x	-	x	-
14BU17	x	-	x	-
14BU19	x	-	-	-
14BU20	x	-	x	-
14BU21	x	-	-	-
14BU22	x	-	-	-
14BU23	x	-	-	-
14BU24	x	-	-	-
14BU25	-	x	-	x
14BU26	x	x	-	x
14BU27	x	-	-	-

Table 3.1. (continued)

Site	Multipurpose Pool	Flood Pool	Other Construction	Vandalism
14BU29	-	-	-	x
14BU30	x	-	x	-
14BU31	x	-	x	-
14BU32	-	-	x	x
14BU37	-	x	-	x
14BU40	-	-	x	-
14BU51	x	-	-	-
14BU52	-	-	-	x
14BU53	-	-	x	-
14BU54	x	-	-	-
14BU55	-	x	-	x
14BU56	x	-	-	-
14BU57	x	-	-	-
14BU59	-	-	x	-
14BU60	-	x	-	x
14BU61	-	-	-	x
14BU70	-	-	x	x
14BU71	x	x	-	x
14BU72	-	x	-	x
14BU73	-	x	-	x
14BU74	-	x	-	x
14BU75	x	x	-	x
14BU76	-	-	-	x

Table 3.1. (continued)

Site	Multipurpose Pool	Flood Pool	Other Construction	Vandalism
14BU77	-	-	-	x
14BU78	x	-	-	-
14BU79	x	-	-	-
14BU80	x	-	-	-
14BU81	x	-	-	-
14BU82	x	-	x	-
14BU83	x	-	-	-
14BU84	x	-	-	-
14BU85	x	-	-	-
14BU86	x	-	-	-
14BU87	x	-	-	-
14BU88	x	-	-	-
14BU89	-	x	-	x
14BU90	x	-	-	-
14BU91	x	-	-	-
14BU92	-	x	-	x
14BU94	-	-	-	x
14BU95	x	-	-	-
14BU97	x	-	-	-
14BU98	x	x	-	x
14BU99	-	x	-	x

erosion was observed during a period when the water level was lowered at the Elk City Reservoir in southern Kansas. In this case two sites were completely destroyed. An estimated 15 to 30 cm. of topsoil had eroded away during a five to six year period (Witty 1973:3). In other instances, sites in coves with little current tend to have their matrix carried off in suspension. However, while a strong current will erode sites, slight currents have been noted to silt in deposits (Jewell 1961:415).

Inundation has other harmful effects in addition to erosion. Leaching and weathering will remove discolorations and other features in shallow sites. When soils and sediments become saturated with water, various sediment components are subject to reduction. Bioturbation of sediments can also occur. This results in transformations of the archeological record and obscures natural soil strata (Garrison 1975:285-86).

Sites located on a shoreline are subject to extreme erosional processes. Wave action is the most extensive and destructive force present in the upper layers of lakes (Garrison 1975:284). Results of these processes are highly visible along the shores of Lakes Bluestem and El Dorado. In areas along the north shore of Lake Bluestem, for example, approximately 50 cm. of prairie soils have been eroded away. Sites between El Dorado Lake's multipurpose and flood pools will be alternately submerged and exposed, subjecting larger portions of sites to shoreline erosion. Cyclical water level fluctuation can eventually destroy, or disturb the deposit, to the point where it becomes of limited investigatory value (Garrison 1975:284).

An example of this kind of destruction is provided by 14BU10. The site appears to be multicomponent, with Woodland and Plains Village occupations. The cultural deposit is located at the shoreline of Lake Bluestem, partially below water level. The site was surface collected in 1972 when the lake level was unusually low. The soil matrix had been eroded away, collapsing the two components. Burned limestone and rock features remained, but the amount of alteration is unknown. Chipped stone and ceramics were recovered, but as the matrix was gone they were obviously not in their previous archeological context. Similar effects have been observed at sites in Arkansas where the upper strata of one open site was totally removed and the depth of site saturation was beyond the coring device used (Garrison 1975:292).

In addition to altering the spatial structure of a site, inundation has adverse effects on artifacts. Soluable tempering agents and natural inclusions in ceramics are leached away. Sherd surfaces are eroded, sometimes making surface treatment identification difficult or impossible. Even lithics can be modified by wave action. Flake scars are worn, and unmodified flakes superficially appear to be modified (Neal and Mayo 1974:11 in Garrison 1975:294; Leaf 1976b:37).

Sites not threatened by inundation are subjected to other harmful agents, including construction, cultivation, and vandalism.

Effects of construction are obvious; wherever possible, recreational buildings and other facilities should be built to minimize detrimental effects. Any sites that are not under water face potential destruction from vandalism. Those sites in cultivated land suffer from modern agricultural practices.

Archeological sites in the El Dorado Lake area have been unscientifically collected for many years. This includes any surface collections made without systematic recording of location, distribution, and context of artifacts recovered. Original site survey records report that many sites used to have very dense surface scatter, but continual collecting by amateurs has resulted in a reduction of artifact density. Increased public utilization of the area which will result from the construction of the lake, obviously has the potential to increase unscientific collecting.

Agricultural practices lead to site destruction. Plowing and discing can significantly alter stratigraphy, features, and artifact distribution. Heavy farm machinery driven across sites also disturbs them. When land is cleared and cultivated, soil erosion increases markedly. Entire sites have been destroyed by increased erosion in northeast Arkansas (Medford 1972:63-5). Signs of increased erosion are readily apparent in the El Dorado area. Ground surface elevations in uncultivated treelines are 20 to 30 cm. higher than adjacent plowed fields. This can result in upper components being mixed, thus decreasing the potential information contained in a deposit.

Effects of these potentially destructive processes can be mitigated in several ways. Exact measures which may ultimately be implemented, must be based on the significance of each site. Therefore, specific means of protection for many sites, threatened by shoreline erosion, must be decided after test excavations have been completed. This will allow decisions to be based on increased knowledge.

Although the effectiveness of most protective measures is unknown, some of those that have been previously proposed include the following. Sites could be riprapped, i.e., covered with protective rock to afford long-term protection. Similar alternatives include sand bagging or covering sites with earth or gravel fill. Protective vegetation planting, or leaving existing shrubs and trees may reduce erosion (Garrison 1975:290, 1977:155). Those sites in agricultural areas should be removed from cultivation upon completion of the dam, but could still be lightly grazed. This would reduce erosion while still allowing the area to be productive. In addition to reducing erosion, protective vegetation would curtail pothunting and indiscriminate collecting. This is due to the fact that sites in dense plant cover are difficult to locate.

CULTURAL RESOURCE MANAGEMENT RECOMMENDATIONS

It has been previously mentioned that more unrecorded sites are probably present in the project area (Root, Chapter 2, this

volume). To properly protect these sites and ameliorate harmful impacts, they of course must be found. It is therefore recommended that those areas where survey data reliability were low due to heavy vegetation cover and that are coincident with low site density localities, be monitored. These investigations should be conducted at times when ground surface visibility is in an improved state. The effects of shoreline erosion have been summarized above, therefore, when the lake is in an operational mode, it is suggested that the shoreline be periodically surveyed. This should be done at least until upland areas have eroded to bedrock (usually 10 to 100 cm.). If periodic shoreline reconnaissance is conducted, unrecorded buried sites may be located and known sites can be monitored. These investigations could be undertaken by a properly trained cultural resource officer, permanently employed at the lake. This would alleviate the need to contract with outside agencies and thus paperwork, time, and money could be saved.

The extent to which a site will be subject to vandalism and indiscriminate collecting is probably related to its location, relative to public use areas. Approximate straight line distances between sites and these areas are given in Table 3.2. If a site is closer to an intensive use area than a low density use area, the latter distance was not calculated.

Management recommendations for sites that are partially or totally above multipurpose pool elevation are given below. Sites that will be impacted by impounded water, regardless of degree, are already scheduled for test excavation. Results of these investigations will provide a more reliable data base on which to make final recommendations. Even though these sites will be tested, remaining cultural deposits need to be protected as much as possible within the limits of feasibility.

14BU10

The site will continue to suffer from shoreline erosion when El Dorado Lake is at multipurpose pool elevation and from fluctuating water levels between multipurpose and flood pools. The deposit is currently being eroded by Lake Bluestem. It is not known how much, if any, of the cultural deposit remains. The area should be reinvestigated if the level of Lake Bluestem falls enough to permit study. During 1977, Lake Bluestem was at spillway elevation (1344 ft. a.m.s.l.) which precluded investigations at the site.

14BU14

The site is situated at multipurpose pool elevation and thus, will be subject to shoreline erosion. At flood pool the deposit will be totally inundated. The site should be protected, at least by taking it out of cultivation. Final recommendations should be based on results of test excavations.

Table 3.2. Approximate straight line distance (in meters) of archeological sites which are above multipurpose pool elevation from project features.

Site	Dam[a]	Administration Buildings	Public Use Area, Intensive Use[b]	Public Use Area, Low Density Use[b]
14BU10	6,800	4,300	400[c]	0[h]
14BU14	11,000	11,500	9,300[d]	4,900[g]
14BU25	11,500	10,800	5,100[e]	-
14BU26	11,300	10,700	5,000[e]	-
14BU29	1,000	3,500	0[d]	-
14BU32	800	3,300	0[d]	-
14BU37	10,100	8,900	3,100	-
14BU52	1,200	2,500	0[d]	-
14BU55	8,000	5,600	700[c]	0[h]
14BU60	11,900	11,300	5,500[e]	-
14BU61	12,000	11,300	5,500[e]	-
14BU70	700	3,500	0[d]	-
14BU71	11,700	12,200	9,800[d]	5,500[g]
14BU72	13,700	13,500	9,300[e]	7,900[f]
14BU73	13,200	13,100	8,100[e]	7,500[f]
14BU74	8,800	7,500	1,600[e]	-
14BU75	12,300	12,700	10,500[d]	6,100[g]
14BU76	8,300	5,800	900[c]	0[h]
14BU77	14,900	14,800	9,400[e]	9,100[f]
14BU89	6,500	7,200	4,800[d]	800[g]
14BU92	7,800	5,300	400[c]	0[h]

Table 3.2. (continued)

Site	Dam[a]	Administration Buildings	Public Use Area,[b] Intensive Use	Public Use Area,[b] Low Density Use
14BU94	6,400	5,300	0[e]	-
14BU98	9,000	8,900	4,300[e]	3,300[f]
14BU99	10,900	10,200	4,700[e]	-

[a]From midpoint of dam axis. [b]Data are based on U.S. Corps of Engineers map entitled "Public Use Areas and Land Allocation, El Dorado Lake." Distances are to the nearest area on the same side of the lake as the site. [c]Quasi Public Areas. [d]Walnut River Area. [e]Bluestem Point Area. [f]Lost Lake Area. [g]Interim Wildlife Management Use Area. [h]Recreation - Low Density Use Area.

14BU25

This buried Archaic deposit is of great scientific value. It will be impacted by flood pool waters and should be totally protected from these adverse conditions. The exact extent of the site is not known. Much of the site is on private land, but nevertheless should be protected from the effects of lake construction. Future test excavations will indicate how much of the deposit is below flood pool. The kind and extent of protection should be based on results of these investigations.

14BU26

The site will be impacted by fluctuating water between multipurpose and flood pool elevations and should be protected. The area is not currently cultivated and should remain in that condition after the lake is in an operational mode. This will offer minimal protection from erosion. Proposed test excavations will provide data needed for final recommendations.

14BU29

The site is located in the planned Walnut River use area and is currently cultivated. The site should be sufficiently protected

by allowing it to become overgrown. If possible, construction should be avoided in the area.

14BU32

The site is in the Walnut River public use area and is threatened by construction of recreational facilities. It is recommended that the site be tested to allow a more accurate determination of its archeological significance. This information can serve to guide final recommendations.

14BU37

The site is on a flowage easement tract, but will be subject to shoreline erosion by the flood pool. The extent of the deposit that will be impacted appears to be minimal. The area needs to be investigated to determine specific measures for appropriate preservation.

14BU52

14BU52 is in the Walnut River public use area. The site is currently covered with prairie grasses and should remain in that condition to minimize pothunting and amateur surface collecting. Construction in the area should be avoided, if possible.

14BU55

Most of the surface area of the site will be subject to inundation at flood pool and will suffer from concomitant erosion by fluctuating water levels. The site contains at least one possible Woodland house structure and thus constitutes a significant cultural resource. It is scheduled for salvage excavation; results of this investigation will provide an excellent data base from which to formulate final recommendations. The area is currently cultivated; this practice should be halted when the lake is finished.

14BU60

A portion of the site will be inundated at flood pool. Test excavations are recommended, which will serve as a guide in determining what protective measures should be employed. The area is currently uncultivated and should remain in that condition to protect it from vandalism and erosion.

14BU61

The site is on a flowage easement tract, above flood pool elevation. The site is not on federal property and impact due to lake construction appears to be minimal. Therefore, no further action is recommended.

14BU70

The site is in the Walnut River public use area. A road, planned for the state park, will go across the site. If the road can be built without disturbing the deposit, this will serve to protect it. However, if land grading or similar procedures need to be employed in road construction, then the site will obviously be at least partially destroyed. Thomas Witty, Kansas State Archeologist, has recently investigated the area and is making a final recommendation. If any of the site remains after construction, it should be allowed to grow over or be planted with grass to protect it from haphazard artifact retrieval.

14BU71

Part of the site is below multipurpose pool elevation and the remainder will be underwater at flood pool. The site is currently being eroded away by Cole Creek and upon completion of El Dorado Lake the situation will worsen. The site should be protected. It will be test excavated and at that time appropriate measures to preserve the site can best be formulated.

14BU72

The site is partially below flood pool elevation. Recommended test excavations should provide data to formulate proper protective measures. The area is presently cultivated. Minimally, the site should be taken out of cultivation to reduce erosion when lake construction is completed.

14BU73

The eastern edge of the site will be under water at flood pool, and should be tested. The locality should at least be taken out of cultivation when the lake is completed to reduce erosion and visibility to vandals.

14BU74

Part of the site is below flood pool elevation and the remainder will be surrounded by the lake at this level. The site should be protected. Proposed test excavations will provide better information on which to base recommendations for preservation. The area should at least be taken out of cultivation.

14BU75

The site will be impacted by fluctuating water levels between multipurpose and flood pools. Results of recommended test excavations can form the basis for deciding if any further mitigative procedures are warranted. The area should at least be taken out of cultivation when construction is completed to preserve the site as much as possible.

14BU76

The occupation is in a flowage easement tract, above flood pool elevation. No further action other than monitoring the site is recommended.

14BU77

The site is above the flood pool, partially within a flowage easement tract. Because the site is on private land, the only recommended action is monitoring.

14BU89

The extent of impact by flood pool waters upon the site have not yet been determined. Test excavation will determine the extent of the deposit that is below flood pool elevation. The site appears to represent an upland prairie Archaic deposit and thus is unique in the project area. The site should be protected from erosion. Its present prairie grass cover provides a sufficient deterent to vandalism.

14BU92

The site will be eroded by fluctuating water level between multipurpose and flood pools. Test excavation should be conducted; final recommendations would be contingent on the results of those

studies. However, the site should at least be taken out of cultivation upon completion of the lake.

14BU94

The site is in the Bluestem Point public use area and is not threatened by inundation. However, this is a high intensity use area and the deposit may be disturbed by vandalism. It is recommended that the site be tested. Recreational facilities should avoid the area as much as possible. The site should be protected subsequent to excavation.

14BU98

The site will be on the shoreline of El Dorado Lake when it is at multipurpose pool and the entire site will be under water at flood pool. The deposit should be tested prior to inundation. Recommendations for protection of the exposed area of the site can be based on results of those investigations.

14BU99

The site will be subjected to erosion by fluctuating lake level between multipurpose and flood pools. The area of the site is currently in cultivation, but should be taken out of cultivation and allowed to become overgrown when the lake is completed. It is recommended that the site be tested and final recommendations should be based on the results of those inquiries.

SUMMARY

Final recommendations for most sites must be based upon information obtained during the test excavation program. This is due to the fact that significance and appropriate protective measures are impossible to assess and recommend without knowledge of subsurface deposits. Regardless of individual site recommendations, one final suggestion is in order. An interpretive center or exhibit should be set up at the lake. This could be located in one of the recreational areas or near the administration buildings. An interpretive exhibit would lead to a better public understanding of the cultural resources of the area. Increased comprehension of the nature and value of archeological sites would probably lead to an increased public appreciation for the need to study, preserve, and protect these sources of knowledge.

CHAPTER 4

TEST EXCAVATIONS CONDUCTED AT EL DORADO LAKE, 1977

Gary R. Leaf

INTRODUCTION

The test excavation strategy at El Dorado Lake has two broad goals: (1) to obtain information about site size and depth, stratigraphic relationships of multiple components, relative state of preservation of cultural debris and refuse (especially faunal and floral remains), and a profile of the soils both on and off each site; and (2) to provide a data base from which to select sites for salvage excavation. This portion of the El Dorado project investigations is specifically designed to focus on intersite variability. Since most of the archeological sites located in the project's impact areas will never be fully excavated, data retrieved from test excavations will comprise all that is known about these sites. Therein lies the importance of mapping, surface collecting, and limited testing; in addition to providing information necessary for choosing which sites merit salvage excavation, the test excavation program will provide data for formulating and testing numerous hypotheses, especially those concerned with settlement location patterns (see Leaf, this volume, Chapter 1, for a more detailed discussion).

Archeological sites located in areas threatend by current or impending construction activities were given priority in the testing program schedule. Two days were spent checking on the status of previously recorded sites that were either within or close to the borrow pit on the east side of the Walnut River. This inspection established that six sites had been destroyed by construction activities. Four sites (14BU53, 14BU3, 14BU40, and 14BU7) were situated near the banks of Bemis Creek and two (14BU13 and 14BU59) were on the east side of the Walnut River (Fig. 2.2). All six sites had been scraped away for dam fill prior to the start of archeological work in 1977. In each case the borrow pit was scooped out to within 1-2 meters of the creek or river bank leaving only a narrow and nearly vertical bank remnant (Fig. 4.1). Chert chips were found eroding into the borrow pit at 14BU53, 14BU3, and 14BU7, but for all practical purposes the six sites are completely destroyed. No future archeological work on them is warranted. 14BU13 was tested by a Museum of Anthropology archeologist in 1968 (Bastian 1978).

An enquiry at the project manager's office at El Dorado Lake revealed that there were two areas where construction was scheduled to begin in the near future: (1) the west borrow pit and (2) the reroute right-of-ways for the railroad and Kansas Turnpike. The area on the west side of the Walnut River immediately north of the dam's axis will be scraped up for dam fill; this construction activity was

Figure 4.1. Borrow excavation for dam fill has destroyed 14BU3.

scheduled to begin sooner, so our investigative efforts focused on archeological sites situated in this area. Five sites were tested during the 1977 field season: (1) 14BU31, (2) 14BU57, (3) 14BU82, (4) 14BU30, and (5) 14BU27 (Fig. 4.2). Three of these sites (14BU31, 14BU82, and 14BU30) are located within the area of the west borrow pit. They are accessible only by fording the Walnut River during low water. The unusually frequent and heavy rains in July and August of 1977, with resultant high water in the Walnut, forced the testing crew to work on more accessible "wet weather" sites, i.e., 14BU57 and 14BU27. All five sites will eventually be completely inundated by the lake's multipurpose pool.

The general procedure at each site was to reconnoiter the vicinity in order to get a preliminary indication of size and surface distribution. Once this was accomplished, a location was chosen as a reference point where the transit could be set up and a contour map prepared for the site. The reference point was placed where it will not be disturbed by cultivation; it was left in place when work at the site was completed. In addition, two monument hubs were placed in unobtrusive locations where they are unlikely to be disturbed. These monuments of known azimuth and taped distance vis-a-vis each other will allow an archeological crew to return to each marked site and determine a precise location with respect to the established grid system by simple triangulation. Monuments and their locational data are recorded on the respective field maps and in site records.

After each site was mapped, the density of surface debris, its distribution, and relative surface visibility were considered in order to determine whether or not a grid controlled surface collection would be productive. None of the five sites were surface collected in this manner, for the various reasons discussed below. An opportunistic collection was made on the sites by sweeping each area after a heavy rain; all visible surface debris was picked up, except for limestone

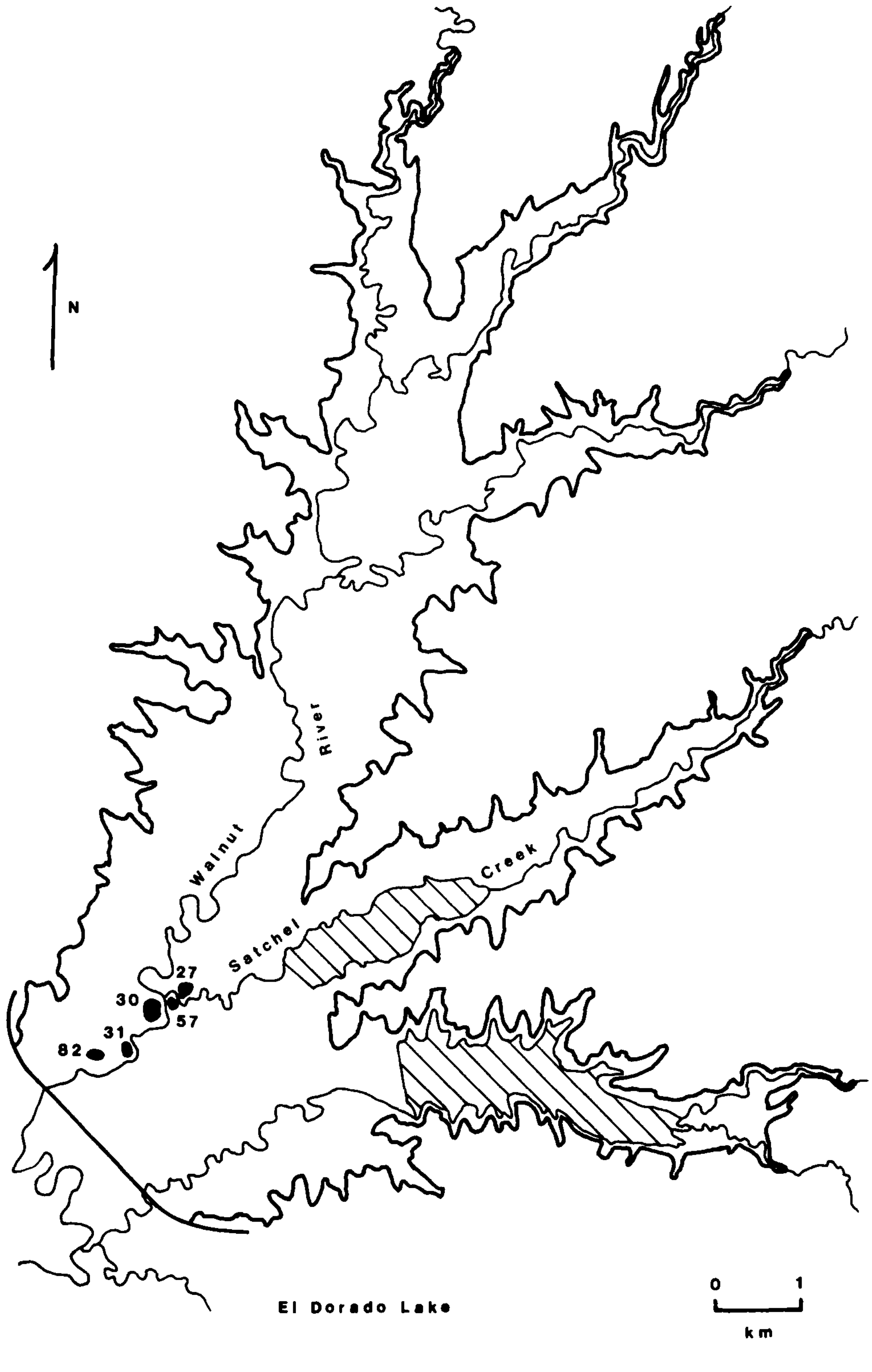

Figure 4.2. El Dorado project area showing the location of archeological sites tested in 1977.

which was sampled. During each subsequent sweep over a site, notes were kept on limits of surface material and internal areas of greatest concentration. This information, in conjunction with an inspection of the artifacts collected, was used to determine the location of test excavations.

The actual digging of test units was primarily conducted with shovels and trowels. However, each site was dug differently in order to determine which combination of field techniques would efficiently and quickly extract the kinds of information required. Thus, even though most digging was done by hand, use was also made of soil samplers, posthole augers, a backhoe, and a heavy scraper. The particular excavation methods used on each of the five sites are discussed in more detail in the paragraphs below. The sites are presented in the order in which they were investigated because field techniques were constantly adjusted throughout the summer to speed up work and to compensate for the nature of cultural deposits under investigation.

Artifact analyses discussed for each site are presented in a standardized framework. For each major class of modified raw material recovered, such as chipped stone, ceramics, and limestone, there is an attempt to derive inferences about the materials' life history in systemic context, i.e., inferences are made about raw material procurement, manufacturing practices, utilization, maintenance, recycling, and discard, loss, or deposition in so far as this is possible given the artifact sample under study (cf. Schiffer 1972, 1976). The intent here is not to provide exhaustive quantitative analyses, but, rather, to formulate a set of interrelated inferences based on macroscopic nominal observations. In all cases, these inferences are not demonstrated conclusions. They are to be considered as a series of interconnected qualitative hypotheses that may be tested with better controlled data from salvage excavations.

As will become readily apparent below, there are several good reasons to be cautious about the epistemic status of conclusions derived from the testing program. A majority of the artifacts recovered from each site were obtained by surface collecting. Since all five sites are situated in cultivated fields, the prehistoric in situ context and association of all surface artifacts have been disturbed. Many specimens have also been physically damaged by farm machinery. On some sites plowing has mixed together different cultural components, so that analyses are hampered by the fact that, except for culturally and chronologically distinct artifact forms, there can be no certainty as to which component deposited which artifacts. Not only are surface materials disturbed, mixed, and sometimes damaged, but they have also been extensively picked over by relic hunters. The amateur collector generally seeks and keeps the more esthetically pleasing objects, such as projectile points, which are, unfortunately, often the most diagnostic with respect to cultural affiliation and chronological position. Therefore, even when the surface collected sample is quite large, it cannot be assumed that it is a representative sample. Artifact collections recovered from subplowzone deposits are extremely small. Less than 0.01% of any of the five sites was excavated; such small artifact samples do not adequately represent the subplowzone deposits they came from. All of these factors and sources of bias affect the demonstrability of analytical inferences offered below.

14BU31

Description

The first archeological site tested in 1977, 14BU31, is located on the west (right) side of the Walnut River 1.1 km. upstream of the dam's axis (Fig. 4.2). This site was first surveyed, surface collected, and recorded in 1967. Eoff and Johnson (1968) estimated that 14BU31 covered about 10 acres; they suggested a Woodland cultural affiliation for surface material on the basis of a small corner-notched projectile point and a few cord marked pottery sherds. There are no records of the site having been investigated by archeologists between 1967 and the present study. 14BU31 was tested because it lies within the borrow area from which soils will be taken to construct the west end of the dam and because it lies within the confines of El Dorado Lake's multipurpose pool.

A contour map was prepared with a transit and metric leveling rod. The reference point was placed on a convenient rise from which the area could be mapped. The site map (Fig. 4.3) shows 1.25 m. of relief. 14BU31 lies on the surface of the Walnut River's first terrace above floodplain; the river has probably cut into the terrace and the site. The extant portion of 14BU31 appears to be centered on a natural levee which is shown as a slight ridge running northeast to southwest. The cultivated field slopes downhill to the northwest and southeast. The southeast gradient drops off rapidly to the riverbank at a fairly steady slope; the land surface to the northwest shows little relief until near the edge of the valley. The surface of the terrace west of 14BU31 exhibits what are thought to be undulations produced by floodwater scouring.

The field in which 14BU31 lies had been planted in wheat in 1977 and had been disced only a few days before archeological work started. Even though there was no vegetative cover, the recently tilled soil obscured the visibility of surface debris. Several heavy thunderstorms subsequently exposed surface artifacts and greatly improved surface visibility. The site's extant dimensions are 130 m. north-south and 90 m. east-west; total observed surface area is 10,036 sq. m. or about 1.0 hectare. Surface debris limits illustrated on the site map represent maximum artifact distribution. Boundaries were determined by surface collecting sweeps made over the entire site after each rainfall. As shown in Figure 4.3, 14BU31 is probably being eroded away by the Walnut River; it is impossible to estimate how much of the site has been washed away, but it could be as much as 50%. Thus, the measured dimensions and surface area are certainly too low.

The density of surficial debris was too light to warrant gridding the site for a controlled surface collection. The amount of visible chert and limestone was heavier along the sides of the terrace's natural levee; these conditions were clearly a product of natural erosion rather than prehistoric cultural activities. No internal site areas exhibited high artifact densities that could be attributed to human behavior. The riverbank that now forms the edge of 14BU31 was searched for evidence that cultural materials were eroding into the

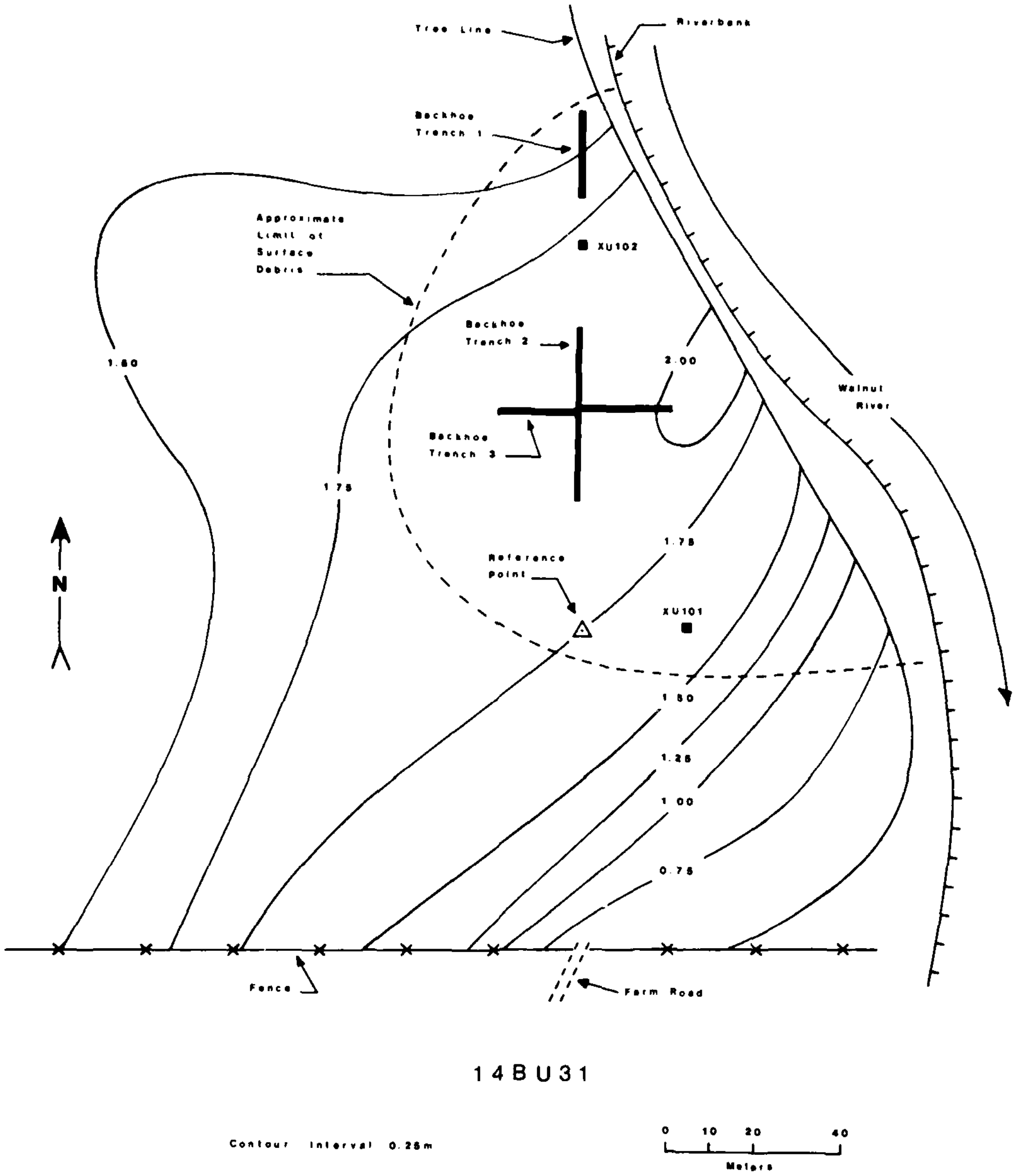

Figure 4.3. Contour map of 14BU31 showing the location of test excavations and limits of surface debris.

Walnut, but with negative results. The river is quite deeply incised in this part of its valley; flowing water is 4.5 to 5.0 m. below the surface of the first terrace. The riverbank is steep and has slumped in places, so it may still be cutting into the site and terrace.

Test Excavations and Features

A two meter grid system was established for 14BU31 on the site map. The transit station was arbitrarily given coordinates 200N100W to insure that all grid units on the site were located in the northwest quadrant. Since this site's reference point was situated in a tilled field, three monument hubs were placed in fence rows at the extremities of the north-south and east baselines where they could not be disturbed by future cultivation. The hubs are painted red for easy visibility. Two 2 by 2 m. square excavation units were staked out. One was placed at 200N75W and the other at 288N100W; grid coordinates for each excavation identify the southeast corner. The two small test pits will be referred to as XU101 and XU102 respectively (Fig. 4.3). The test units were dug with hand tools (shovels and trowels); some excavation levels had their backdirt sifted through a ¼-inch mesh screen. Large artifacts, those that were 2 cm. or greater in any dimension, were plotted in three dimensions to the nearest centimeter; horizontal measurements were made from the excavation unit's southeast reference hub and elevations were measured with the transit. The floors of all completed levels were scraped clean and inspected for feature stains.

XU101 was placed inside the posited southern limit of surface debris and on the levee slope nearest the Walnut River (Fig. 4.3). The plowzone was stripped off to a depth of 20 cm. and sifted through a screen. Very little cultural material was recovered, but the level did contain a lot of gravel and charred wheat stubble. Level 2 (20-30 cm.) was excavated in the same manner as level 1, but even fewer artifacts were recovered so the second level can be considered culturally sterile. At this point the test square was decreased in size and the southern 1 by 2 m. half was dug in 10 cm. levels to a depth of 1.0 m. below ground surface. This work was accomplished quickly because it was designed to check for buried components. The sifting of backdirt was discontinued at level 3; backdirt from levels 3 to 9 was examined by searching through it a little at a time with a trowel. No artifacts were obtained in any of the seven lower levels. When the desired 1.0 m. depth was reached, two postholes were augered through the sediments for another meter (Fig. 4.4). No buried cultural horizons, artifacts, or features were found.

The testing in XU101 demonstrates that the cultural deposit near the southern edge of 14BU31 is shallow and disturbed by cultivation (Table 4.1). The few artifacts that were recovered came mostly from the plowzone. The west wall of XU101 was profiled; three strata were observed. The plowzone is a dark grayish brown humic soil that was loose and full of charred wheat stubble. Stratum 2 is a more compact silty clay unit, brown in color, that was quite moist; it extended from the bottom of the 20 cm. plowzone to a depth of 90 cm. From 90 cm. to an unknown depth below surface is stratum 3, a very dark gray silty clay that was also quite moist (Fig. 4.5). None of the strata contain much sand. Except for the plowzone, the transition from one stratum to the next lower is more of a subtle continuum than a sharp boundary.

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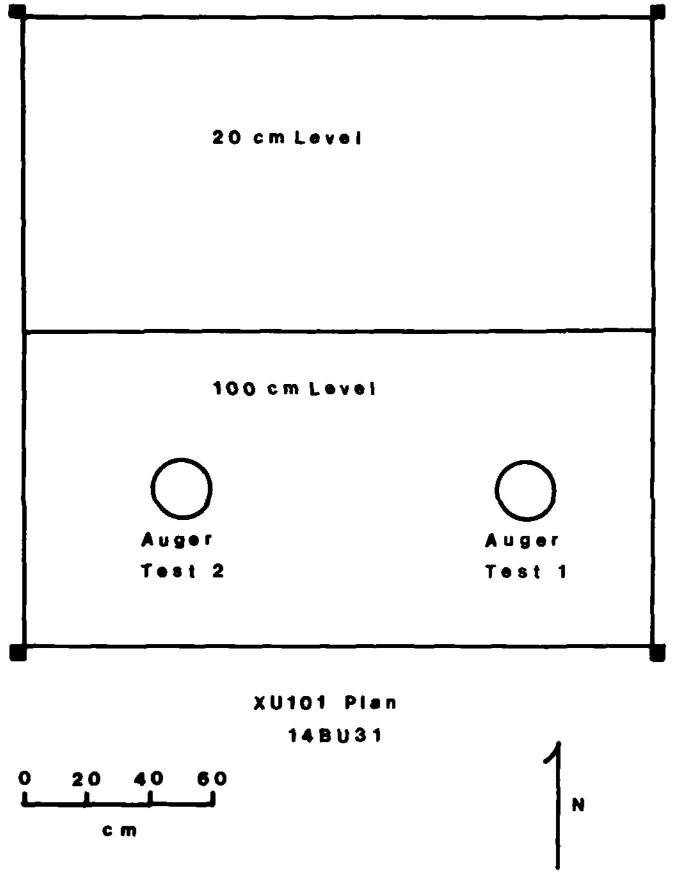


Figure 4.4. Plan view of XU101 (14BU31).

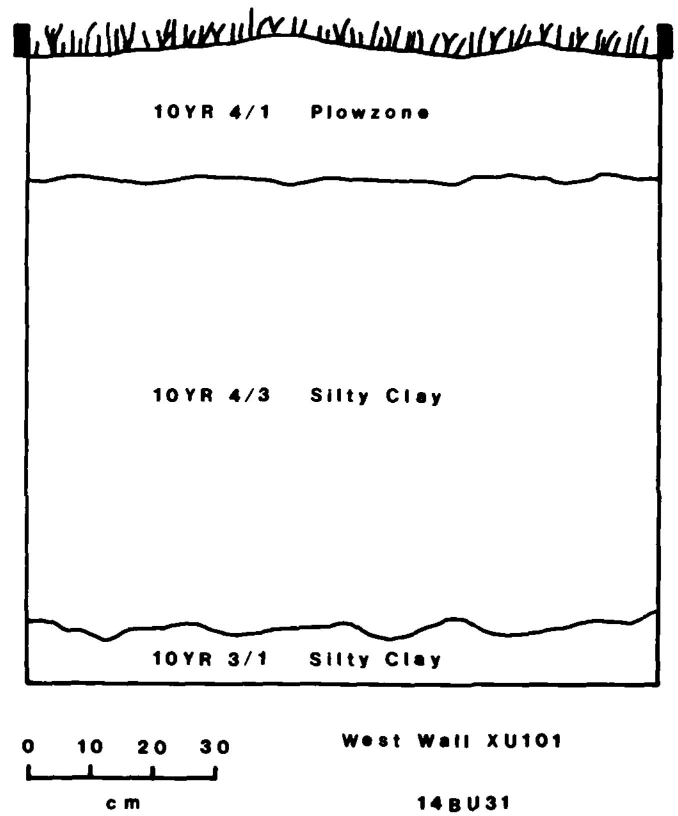


Figure 4.5. West wall profile from XU101 (14BU31).

Table 4.1. Depth distribution of artifacts recovered in XU101 (14BU31).

Level	Limestone	Chipped Stone	Pottery	Bone
1	27	12	2	1
2	2	1	-	-
3	-	-	-	1
4-9	-	-	-	-

Excavation unit 102 was placed close to the Walnut River and on top of the levee. If prehistoric occupation of 14BU31 was actually related to the existence of a natural levee, then cultural deposits were expected to be thicker, hence deeper, and possibly offer a better chance of finding intact subplowzone deposits. Once again, the plowzone was excavated to a depth of 20 cm. as a single unit and sifted. This first level contained cultural debris as expected (Table 4.2). Thirty-two artifacts were plotted in level 2: 13

Table 4.2. Depth distribution of artifacts recovered in XU102 (14BU31).

Level	Limestone	Chipped Stone	Pottery
1	22	27	-
2	20	14	3
3	24	2	-
4	48	3	-

chipped stones, 14 limestones, 3 potsherds, 1 bone, and 1 piece of charcoal (Fig. 4.6). One small round stain was observed; when it was cross sectioned it made an abrupt turn and so was diagnosed as a rodent burrow. Aside from the plotted artifacts already mentioned, the sediment matrix from this level contained numerous flecks of burned earth and charcoal. The soil did not change to a lighter color as was experienced in XU101. The evidence indicates that level 2 was going through an intact occupation zone, but the distribution of plotted artifacts appears to be random (Fig. 4.6).

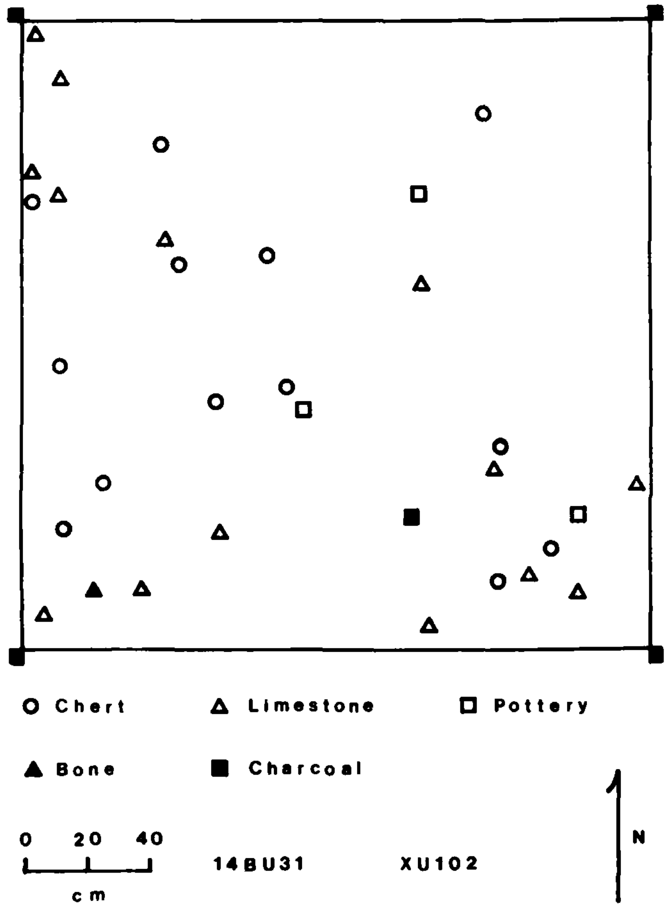


Figure 4.6. Distribution of plotted artifacts in XU102, level 2 (20-30 cm.) (14BU31).

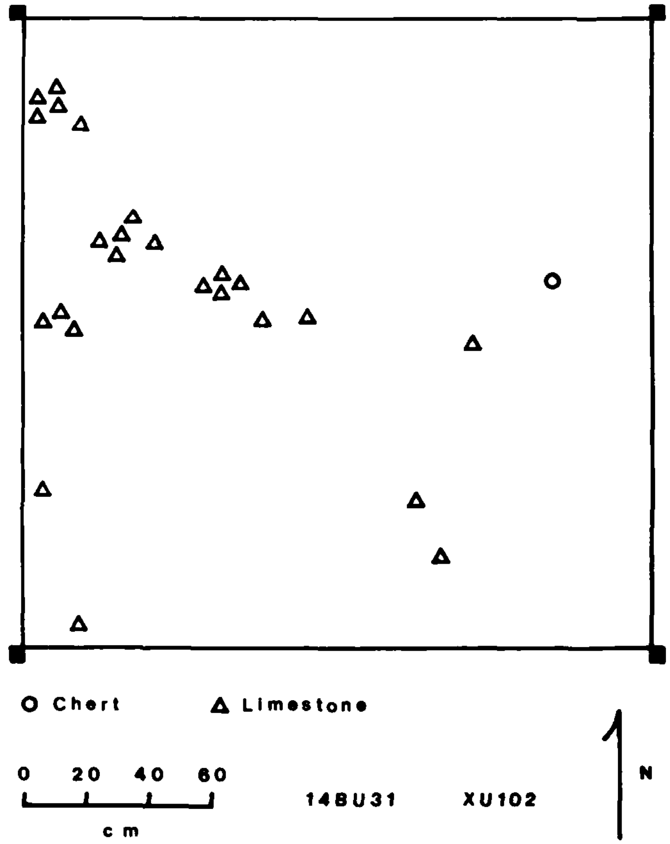


Figure 4.7. Distribution of plotted artifacts in XU102, level 3 (30-40 cm.) (14BU31).

The same situation prevailed in level 3 (30-40 cm.) except that there were fewer plottable artifacts (Fig. 4.7). The apparent concentrations shown in Figure 4.7 are probably the result of large pieces of limestone breaking into smaller fragments. The backdirt could not be screened because the moist clay would ball up and not pass through the sifter; we resorted to searching through the backdirt as before. The soil near the bottom of level 3 became lighter in color and contained fewer artifacts than the upper dark soil; this was a clear indication that the excavation had gone through the bottom of the occupation zone.

Excavation of level 4 to a depth of 50 cm. confirmed that the bottom of the site had been detected. However, the top of a feature (302) was encountered in the southwest quarter of this level. The feature first appeared as a circular concentration of limestone at a depth of 42 cm.; the soil inside the ring contained few pieces of limestone and was distinctly darker, less compact, and more finely textured than surrounding soils (Fig. 4.8). When the feature was cross sectioned it turned out to be a basin-shaped pit whose sides and bottom were lined with burned limestone and a few pieces of chert. The pit is 70 cm. in diameter at its origin and 25 cm. deep.

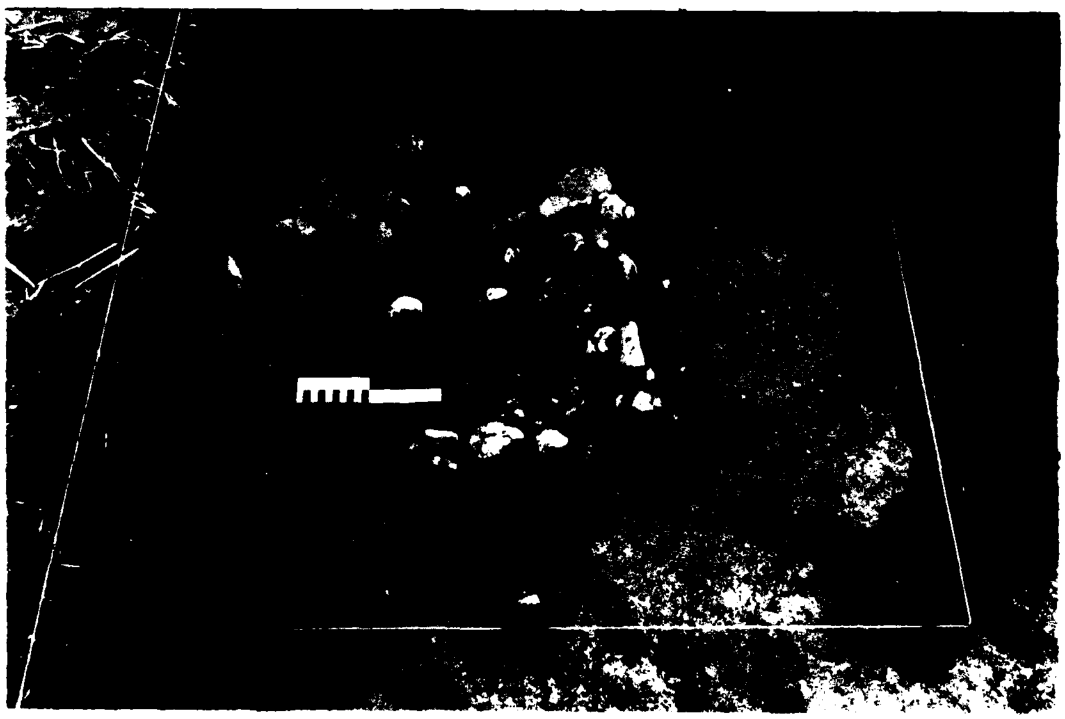


Figure 4.8. Plan view of partially excavated feature 302, XU102 (14BU31).

The walls and bottom had not been burned, so no fire was built in the pit. Most, but not all, of the limestone and chert contained in the feature exhibited thermally induced color changes, i.e., a distinct pink to red surface color. The center of the pit, however, was filled with loose dark soil that contained flecks of charcoal and burned earth, but in no greater frequency than the general cultural horizon described above. The entire pit matrix was saved for water flotation and screening.

It is hypothesized that the feature functioned as a roasting pit. The sequence of events involving the pit can be reasonably reconstructed as follows: (1) a shallow basin-shaped pit was excavated, (2) pieces of limestone and chert were heated in a nearby hearth, (3) the hot rocks were placed in the pit in such a manner as to completely surround food items being roasted, (4) the pit was sealed with soil and allowed to cool, (5) when the pit was reopened the cooled limestone and chert on top were tossed aside and the cooked food removed, and (6) the roasting pit was backfilled. This posited feature function and sequence of events accounts for the scatter of burned limestone around the pit, the absence of burned sides and bottom, the presence of burned limestone and chert along the sides and bottom, and the near absence of rock in the pit's center. It must be mentioned however, that if this interpretation is accurate, there are three possible ways in which charred food items could have gotten into the pit and recovered during flotation: (1) by being brought in as debris when heated rock was transferred from hearth to roasting pit, (2) as a product of food roasting in the feature, and (3) as part of the general midden used to backfill the feature. The recovery of charred flora and fauna from the matrix does not necessarily indicate which food resources were actually roasted.

Data retrieved from the two hand excavated test pits indicated that an undetermined portion of 14BU31 had been destroyed by plowing. The northern area of the site did contain some intact cultural deposits below the plowzone, the top of which was disturbed by cultivation. In order to determine the size and distribution of undisturbed deposits, a number of backhoe trenches were laid out; they were also used to quickly check for buried components. These trenches were staked out according to the site grid system; string was used to guide the machine operator. Backhoe trench 1 was excavated along the west edge of the north baseline from 300N100W to 320N100W; it was 20 m. long and averaged 0.75 m. in width. Backhoe trench 2 was also excavated along the western edge of the north baseline; its coordinates are 230N100W to 270N100W. Trench 2 was 40 m. long and 0.75 m. wide. Backhoe trench 3 was laid out and excavated at a right angle through the center of trench 2; the two trenches form a large cross in the approximate center of the site (Fig. 4.3). For logistical reasons the two arms of trench 3 were staggered slightly. Backhoe trench 3 was excavated from 250N120W to 250N80W; the trench was 40 m. long and 0.75 m. wide.

Backhoe trench 1 was excavated to variable depths; it was taken down deeper at each end than in the middle (Fig. 4.9a). At the southern end the trench reached a maximum depth of 3.1 m., the northern

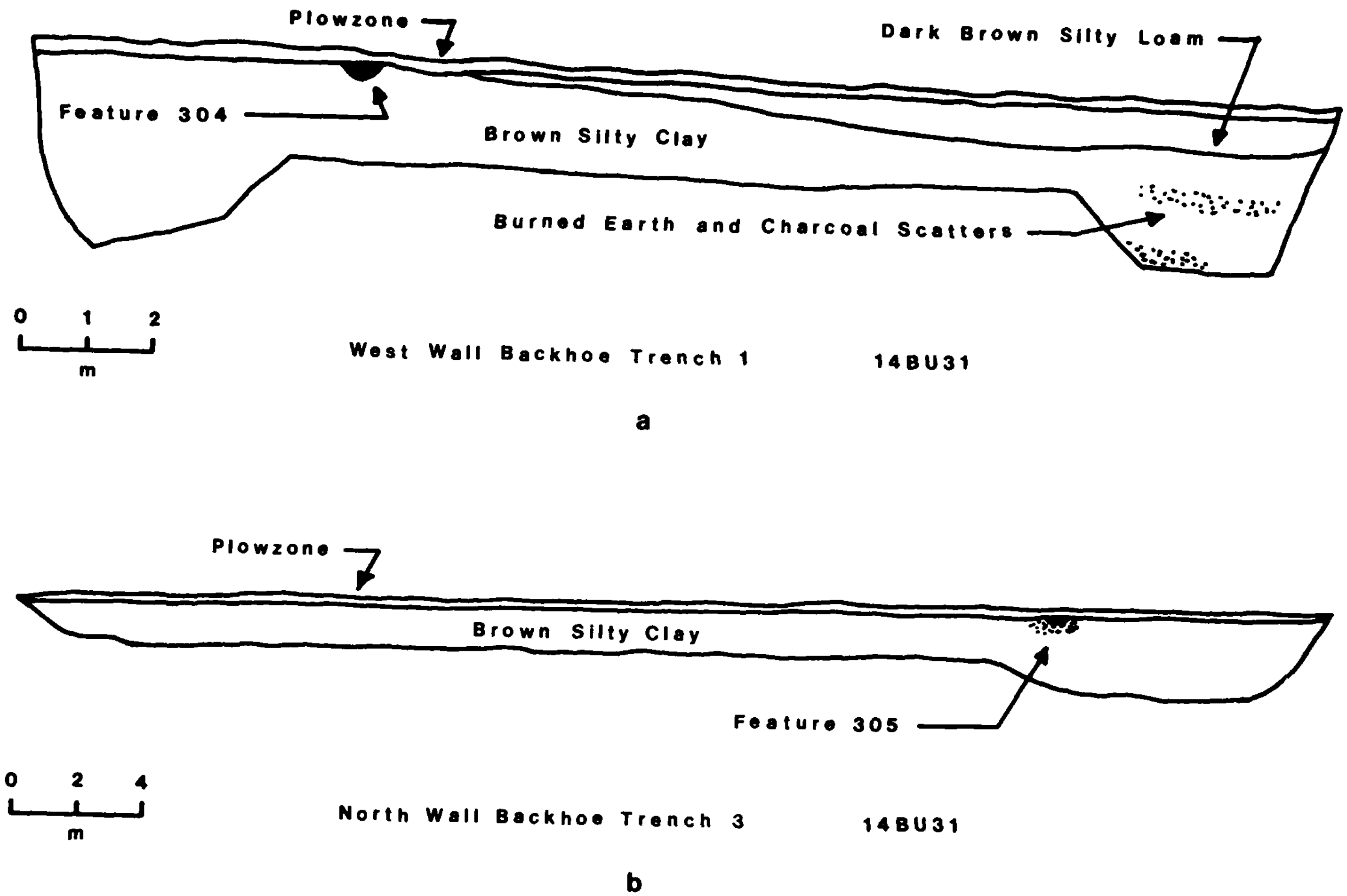


Figure 4.9. Profiles of backhoe trenches 1 and 3 showing the location of features and naturally deposited scatters of burned earth and charcoal (14BU31).

end reached 2.5 m., and the middle averaged 1.5 m. below ground surface. The excavation transected the northern slope of the natural levee where artifacts (mostly limestone) were visible on the field's surface. It can be seen in the profile that the dark brown silty loam is much deeper at the northern end of the trench than at the southern. This soil unit comprises the plowzone on the site as well as the cultural horizon detected in XU102. The increasing downhill depth of this soil body, as one moves north along the trench, indicates that erosion of the loose plowzone has deposited about 60 cm. of topsoil at the base of the levee. Notice also that the soil unit in question and the plowzone are coterminous at the southern end of the trench.

Below the dark brown silty loam was a brown silty clay stratum that continued to an unknown depth. This lower sediment unit appeared to be homogeneous except at the northern end of the trench where burned earth and charcoal were scattered in the unit in vertically and horizontally distinct bands. The two bands were examined carefully for association with cultural materials, but none could be found. In the absence of artifact associations, these burned earth and charcoal scatters in the profile are interpreted as having a noncultural origin. Prairie and/or forest fires in the river bottoms could have produced charcoal and burned earth which were swept away and deposited by floodwater. A large charred log was extracted from the trench's west wall out of the lower scatter in anticipation that a geomorphologist may want a radiocarbon date for the formation of the river's first terrace.

The profile of backhoe trench 1 also shows that a feature was unearthed near its southern end. Feature 304 was a basin-shaped pit completely filled with limestone; it also contained burned earth and charcoal. The trench nicked the eastern edge of the pit (Fig. 4.9a); which measured 60 cm. maximum north-south diameter and 31 cm. deep. The pit's top has been truncated by plowing. Feature 304 is circular in plan and profile; its walls and bottom showed no evidence of burning. The entire pit contents were excavated and taken to the laboratory for water flotation, screening and analysis. This feature is nearly identical in shape and contents to feature 302 found in XU102, except that unlike the latter it showed no evidence of having been opened for food removal and backfilled with midden soil. Feature 304 in trench 1 may have been backfilled with limestone; it too is interpreted as a roasting pit. A second limestone filled basin-shaped pit was exposed in the trench's east wall a few meters south of feature 304. However, heavy rainfall caused worry about trench walls caving in on the crew, so the location of this pit was recorded and the trench backfilled; the pit was not excavated.

Backhoe trenches 2 and 3 revealed very little evidence of cultural deposits and no artifacts whatsoever. Both trenches exhibited the same basic sediment stratigraphy observed in the first trench, except that no burned earth and charcoal scatters were found. The eastern end of trench 2, i.e., the end closest to the Walnut River, was excavated to a depth of 1.3 m. to check for buried components; the rest of trench 2 as well as trench 3 averaged 0.8 m. in depth. A small lens of consolidated

ash was uncovered at 251.9N72W (Fig. 4.9b); it measured 19 cm. east-west and was 7 cm. thick. Most of the ash lens (feature 305) had been removed by the backhoe and it had been struck and scattered by farm machinery. The ash was removed from the trench wall and taken to the laboratory for flotation and analysis. The lens indicates that prehistoric occupants at 14BU31 cleaned debris from their hearths and discarded it.

The fieldwork at 14BU31 was frequently interrupted by heavy thunderstorms; nearly three weeks went by between the start and completion of testing. The one positive contribution made by wet weather was that it forced the crew to make repeated surface collecting sweeps across the site. This resulted in the largest collection of artifacts from any single site tested in 1977. The data presented from test excavations, backhoe trenches, and distribution of surface artifacts, demonstrate that much of 14BU31 has been disturbed and/or destroyed by cultivation and river cutting. There is a small amount of subplowzone cultural deposit left in the north-central area of the site; the intact occupation zone is located on top of a natural levee in the general vicinity of XU102 (Fig. 4.3).

Artifact Analyses

The conclusion will be supported in much more detail in the paragraphs that follow, but 14BU31 is a single component Woodland site. This statement, in conjunction with the fact that most of the artifacts to be analyzed and interpreted in this section were recovered from the site's surface, is ample justification for treating the surface and excavated materials together as an assemblage. And, since there appears to be so little of the site left intact, all of the extant collections known to exist from the site are dealt with here; the surface collection made in 1967 is included in the analysis. This was done in order to obtain the maximum amount of information about 14BU31 within the present conceptual framework because, to anticipate another conclusion, it will be recommended that the site be assigned a low priority salvage excavation status. Thus further work at the site is unlikely.

Prehistoric artifacts from 14BU31 represent nine kinds of raw material: (1) burned earth, (2) sandstone, (3) limestone, (4) bone, (5) charcoal, (6) shell, (7) pottery, (8) quartzite, and (9) chert. The presence of burned earth in the soil was noted throughout the excavation of levels one through three in XU102. Most of this material was not large enough to be collected, however 32 large pieces were saved for laboratory examination. Five large burned earth specimens were picked up during surface collecting, and one piece was recovered from the roasting pit (feature 304) in backhoe trench 1. All of them were studied under a microscope for evidence of temper, sherd surfaces, and wattle impressions. These items are just burned earth and have oxidized and hardened surfaces. They are definitely not pottery fragments and there is no indication that they are daub fragments. Burned earth could have been produced by the cleaning out or rebuilding of used hearths.

The sandstone sample from 14BU31 is composed of four small fragments; 3 pieces were surface collected and 1 came from the plowzone in XU101. None of the specimens have been burned or worked; their total weight is 48 gm. The fragments are reddish-brown in color and have a coarse texture. Sandstone was often used to make grinding tools, such as manos and metates, but the use to which sandstone was put at 14BU31 can not be inferred from the specimens recovered.

Limestone is one of the more numerous artifact classes; the collection contains 991 specimens that together weigh 53,077 gm. (about 117 lbs.). Most of the limestone was excavated from the two roasting pits discussed earlier, but a little over a third of it came from general excavation levels and from the site's surface. Over half of the sample shows the characteristic color changes from exposure to heat: pink or red. Limestone examined in the project area is light gray or grayish white (unburned) and is so soft that it can easily be scratched with the fingernail. It is therefore possible that much more of the 14BU31 limestone had been burned; surfaces that once exhibited a pink color may have been worn or eroded away. This problem can be resolved with a few simple field experiments. At any rate, the hypothesis may account for why burned and unburned limestone both were recovered from the roasting pits. The data presented in Table 4.3 shows that most of the roasting pit limestone was heat discolored, whereas most of the specimens from general excavation levels and the surface have no such color change. The latter artifacts were exposed to more weathering, so most of the pink surfaces may have been eroded away.

Table 4.3. Limestone counts, weights, and distribution (14BU31).

	Number	Weight (gm.)
Surface Collection and Excavation Levels		
Burned	132	5,463
Not Burned	161	11,586
Roasting Pits		
Burned	480	28,045
Not Burned	218	7,983
Site Totals		
Burned	612	33,508
Not Burned	379	19,596

One large piece of limestone collected from the site's surface in 1967 has five shallow circular depressions on one surface. The depressions average 3.3 cm. in diameter and range from 0.5 to 1.1 cm. in depth. The sides and bottoms of the well preserved depressions are pitted or crushed; they show no signs of having been drilled into the limestone block. The block itself weighs 4,830 gm. and has a skewed rectangular shape; it is 6.5 cm. thick, 24 cm. long and 20 cm. wide. Except for the five small pits on one surface, the artifact has not been intentionally shaped; it does not appear to have been broken, but it does exhibit scratches and gouges from farm machinery. The limestone block was probably used as an anvil on which to crush open nuts; it is too soft to have been used as a flint knapping anvil.

Limestone seems to have functioned in several different ways at 14BU31. It was probably used to pave or outline hearths, heated limestone was used to cook food in roasting pits, and it was used at least once as an anvil on which to pound or crush other items, probably nuts. It will also be shown below that limestone was crushed and used as temper in pottery vessel manufacture. Large pieces of this rock recovered at 14BU31 do not occur naturally in the terrace sediments, so the limestone had to be brought to the site. The closest known limestone outcrop is 800 m. west along the valley's edge.

Animal bones are not well preserved at 14BU31. The proximal end of an ulna and femoral head from a deer (Odocoileus sp.) were picked up in the surface collection. They are probably not prehistoric elements. Some fragments of modern mollusc shell were also found on the surface. Excavated fauna includes an unidentifiable tooth fragment in level 2 (20-30 cm.) and a bone fragment in level 3 (30-40 cm.) of XU102. A piece of calcined bone too small to identify was recovered in the plowzone of XU101. Tiny flecks of charcoal were encountered throughout the midden levels in XU102.

Bone and charcoal recovery was much better in the excavation level soil samples and feature matrices that were subjected to water flotation. Bone, shell, charcoal, and charred seeds were found in nearly all processed samples (Table 4.4). It will be recalled that the entire matrix of each feature and a ½ bushel sample from the subplowzone levels of XU102 were taken for flotation and screening to recover microdebris. Some of the shell appears to be fragments from river mussels, the rest of it is composed of nearly completed gastropod shells. Since the gastropod shells are not burned, they are probably natural inclusions. Shell fragments from river molluscs represent the remains of prehistoric food items. It is interesting to note that shell occurs only in the features which apparently provided conditions more favorable for shell preservation than did the general midden. The limestone in features 302 and 304, and the ash concentration in feature 305 would have neutralized soil acids and helped preserve shell.

Feature 302 produced many small unidentifiable bone fragments, a rabbit molar (Sylvilagus sp.), and a very small fish vertebra (0.14 mm. diameter) that could not be further identified. No identifiable bone came from feature 304, but it did contain small burned and unburned fragments. Both roasting pits also contained fragments of limestone,

Table 4.4. Water flotation recovery from excavation levels in XU102 and three features (14BU31).

	Level		Feature		
	2	3	302	304	305
Charred Flora					
Chenopodium	+	+	+	+[a]	-[b]
Polygonum	+	-	+	-	-
Ambrosia	+	-	-	-	-
Celtis	-	+	-	-	-
Amaranthus	-	-	+	-	-
Gramineae	-	-	-	+	-
unidentified	-	+	-	+	-
charcoal	+	-	+	+	+
Bone	+	+	+	+	+
Limestone	+	-	+	+	-
Burned Earth	+	+	+	+	-
Debitage	+	+	+	+	+
Shell	-	-	+	+	+

[a]Present. [b]Absent.

burned earth, and some chert debitage. Charred floral remains from the two pits include goosefoot (Chenopodium sp.), knotweed (Polygonum sp.), ragweed (Ambrosia sp.), and pigweed (Amaranthus sp.); seeds from these plant genera are often recovered in archeological deposits in North America (Struever and Vickery 1973). Such plants often invade disturbed areas, such as archeological sites and plowed fields. Vegetation cover is occasionally burned from fields in the project area, so charred seeds were not necessarily deposited by prehistoric man. However, since there are larger numbers of charred specimens in roasting pits (relative to numbers in general excavation levels), they may represent plant products gathered, cooked, and eaten by the site's inhabitants. The low frequencies of seeds, as well as the presence of uncharred examples, indicate that specimens recovered from shallow excavation levels are not unequivocally prehistoric. The ash lens (feature 305) contained no identifiable seeds, but did contain charcoal flecks, unidentifiable bone fragments, gastropod shells, and chert debitage.

The water flotation and screening data suggest that some plant and animal products were cooked in roasting pits. The large numbers of charred goosefoot, knotweed, and pigweed seeds in the features (302 and 304) indicate that they were probably not deposited when the pits were backfilled with midden soil. The problem of determining whether or not the floral remains were brought in as incidental debris when heated rock was transferred from a hearth to the pits or was a product of food roasting in the features can not be solved with present information.

The pottery sample is composed of eight body sherds and one small sherd fragment; four sherds were surface collected in 1967, two in 1977, and two sherds and the fragment were recovered in test excavations. All the ceramic artifacts have cord marked exterior surfaces; eight of them have smoothed interior surfaces. The interior surface of one sherd shows the dragged temper particles and scratches characteristic of scraping (Shepard 1956). The meager distribution data (Table 4.5)

Table 4.5. Pottery temper distribution (14BU31).

	Limestone	Indurated Clay
Surface Collection	3	3
Excavation	2	1

illustrates that there is no apparent difference in temper when surface collected sherds are compared with excavated specimens. The cord marked body sherds are either tempered with limestone or indurated clay. Exterior surface treatment on four specimens is distinct enough to observe that three had been marked with "S" twisted cords and one with "Z" twisted cords (for criteria differentiating cord twists see Hodges 1964: 128). The artifacts are not large enough to be certain, but they were probably slapped with a cord-wrapped paddle in order to shape the vessel they came from. Sherd colors are light brown exterior surface, dark gray to black core, and light to dark brown interior surface. No rim, neck, shoulder, or basal sherds were found, so no inference can be made concerning vessel shapes or sizes.

Three quartzite cobbles were surface collected in 1977. All three have culturally unmodified smooth and rounded surfaces characteristic of river rolled gravel. Quartzite in the El Dorado area is not a common surface rock. The specimens found on 14BU31 may have been collected in the Arkansas River (to the south) or the Smoky Hill River (to the north) where such cobbles are more common. Two of the artifacts are somewhat flat and oblong in shape; there is battering and crushing concentrated on rounded ends and corners. They have the shape, hardness, and wear characteristic of hammerstones; and could have been used to percuss chert or peck and abrade limestone or sandstone. The third specimen is a cobble fragment having the same general size and shape as the others,

except that it has been broken. It exhibits no modification, other than having been brought onto the site. The dimensions and weights of all three quartzite artifacts can be found in Table 4.6. The two com-

Table 4.6. Quartzite artifact dimensions and weights (14BU31).

Catalog Number	Length (mm.)	Width (mm.)	Thickness (mm.)	Weight (gm.)
A5001677-00151[a]	63.6	38.7	19.4	68.8
A5001677-00150	67.7	56.9	37.0	208.5
A5001667-00015	63.2	42.9	31.2	122.1

[a]Broken specimen.

plete hammerstones are more dissimilar in weight than in other size dimensions. A variety of hammerstones of various weights would be required by a prehistoric flint knapper; a heavy hammer would be useful for block and core preparation, but a lighter hammer would be more useful for blank detachment and rough shaping of preforms. Hammerstones are direct evidence for the occurrence of a hard-hammer flint knapping technique; they could also have been used to shape ground stone tools by pecking and/or abrading.

The largest class of artifacts from any site tested in 1977 is composed of chert. The chert collection from each site was examined and processed in the same way so as to obtain comparable results. The analytical class criteria are explained during the presentation of data and inferences for the 14BU31 lithic assemblage, thus there will be no need to repeat definitions when collections from other sites are discussed. The analytical procedure is oriented toward the extraction of technological inferences; the goal is to obtain information concerned with raw material procurement, manufacturing sequences, and tool utilization. The particular questions asked of each lithic collection within these rather broad technological subjects are specifically geared to take into account the limitations placed on analyses of surface collections.

The prehistoric flint knapper had to obtain suitable raw material before he could produce the tools and other chipped stone items needed for day to day existence. Chert is, of course, ubiquitous in the Flint Hills. A preliminary study of chert available in the project area has been made in an attempt to determine source locations and characteristics which may be used to identify the various sources (Haury, this volume, Chapter 7). The cherts reported in this chapter have been recovered from archeological sites, so they represent raw material varieties used by prehistoric populations to manufacture tools. They are cherts that were selected and transported to the sites for use. "Selected raw material" is a piece of chert, or some other kind of chippable stone,

that: (1) is large enough to have been made into a core or some other kind of chipped stone artifact, and (2) could not have entered the archeological record by natural processes. If a piece of selected raw material has one fresh flake scar, it is classified as "tested raw material" otherwise it is referred to as "unmodified raw material."

There are 10 large pieces of chert that were selected and transported to 14BU31 as raw material (Table 4.7). All of them fulfill the

Table 4.7. Selected raw materials (14BU31).

Chert Type	Unmodified	Tested
Florence	2	4
Foraker	3	1

criteria for inclusion in the selected raw material class. An examination of Table 4.7 shows that six of the artifacts are Florence chert and that four are Foraker chert (see Haury, this volume, Chapter 7, for descriptions of these cherts). It is assumed that the prehistoric flint knapper had criteria that were applied to potential raw material to help him sort out and select suitable pieces. Exactly what those criteria were is an interesting problem, but is beyond the scope of this study. One possible criterion, however, is evident in that 5 pieces of selected raw material had been tested, i.e., a flake was struck from them to help the knapper judge their usefulness or technological suitability. Half of the artifacts in question were tested, the other half were not (Table 4.7). If the frequency of testing in the selected raw material sample is representative of the entire prehistoric assemblage, then it appears that Florence chert had to be tested more often than Foraker chert. Conceivably, the quality of Florence chert was more difficult to determine by simple inspection, so it had to be tested more often. All ten of the artifacts have cortex or patina covered surfaces, except where they were tested; none of them exhibit thermally induced color changes. The Florence specimens are either blocky, nodular, or gravel in form; Foraker pieces are blocky. These are the shapes in which the respective cherts occur naturally (Haury, this volume, Chapter 7) and indicates that flint knappers procured raw materials from outcrop, talus, and riverbed source locations. Because the river terrace on which 14BU31 is situated contains natural gravel, it was not always easy to distinguish prehistorically procured from naturally occurring gravel; this problem is considered in greater detail below. All of the selected raw materials were collected from the site's surface (Table 4.8).

Procured raw materials are transformed into cores, tools, and various kinds of waste by the application of chipping techniques. A core is a piece of chert, or some other type of chippable stone, that exhibits: (1) more than one flake detachment scar, (2) one or more cleavage

Table 4.8. Chipped stone artifact distribution (14BU31).

Class	Surface Collected	Excavated
Unmodified Raw Materials	5	-
Tested Raw Materials	5	-
Cores and Core Fragments	55	2
Chunks and Shatter	136	16
Complete Flakes	106	6
Proximal Flake Fragments	163	12
Other Flake Fragments	313	38
Resharpening Chips	7	2
Potlids	9	3
Utilized Blanks	2	-
Unifaces	9	1
Bifaces	30	-

faces, and (3) one or more striking platforms. The flake detachment scars observed on core cleavage faces are sometimes confused with retouch chipping found on unifacial and bifacial tools. In general, "retouch" refers to the systematic and continuous modification of an edge or surface which produced an edge, point, or some other form. Retouch scars are also generally smaller than core flake scars, but there can be size overlap when small cores and large tools are compared (hence a possible source of confusion). Retouch, however, is characterized by regular and patterned invasiveness, whereas core cleavage faces can not be so characterized. The flakes detached from cores can be used as they are or can be shaped by retouch into unifacial and/or bifacial tools; such flakes (the term here is used in the generic sense) are called "blanks." One function of cores in a lithic technological system is to provide the flint knapper with blanks. From this it can be seen that the smallest blank detachment scar may be smaller than the largest retouch scar, but that the smallest blank detachment scar will always be larger than the smallest retouch scar, i.e., there is a minimum size

below which blanks can not go and still be used as, or subsequently shaped into, tools. The point being made here is that with regard to differentiating cores from large tools, and cleavage faces from retouch, there are no absolute delimiting criteria; the distinguishing features and parameters are best established by intra-assemblage analysis.

Table 4.9 shows that there are 44 cores and 14 core fragments in the 14BU31 lithic assemblage. Core fragments are pieces of broken cores that may or may not exhibit all of the class significata; they do exhibit some of them and, in addition, they have one or more freshly broken surfaces that do not also exhibit the features of a flake's ventral surface (such as bulb of percussion, ripples, or eraillure scar).

Table 4.9. Cores and core fragments (14BU31).

	Chert Type			
Core Type	Florence	Foraker	Light Gray	Miscellaneous
Polymorphic	19	7	5	1
Discoidal	1	2	2	1
Bipolar	-	-	1	1
Single Ended	1	1	-	-
Double Ended	-	1	-	-
Tabular	-	-	1	-
Fragment	10	1	1	1

Cores are classified according to how many striking platforms and cleavage faces they exhibit as well as the spatial relationships both have vis-a-vis each other (cf. White 1963; Montet-White 1973). Polymorphic cores have randomly placed flake scars each of which may have its own individual striking platform (Fig. 4.10b). Single ended cores have one striking platform from which all detachments have been made. There may be one or more cleavage faces on a single ended core; the number of these specimens collected from El Dorado archeological sites does not yet justify distinctions within the class based on the number of faces. The same is true of double ended cores which have two striking platforms opposing each other (Fig. 4.10a). Bipolar cores are quite distinctive; there are several different varieties, but they all have two surfaces of percussion at opposite ends of a striking axis: a striking platform and a base. The base rested on a hard anvil when the core was impacted, so the base exhibits crushing and small flake scars (Fig. 4.10c). A discoidal core has two roughly circular cleavage faces that

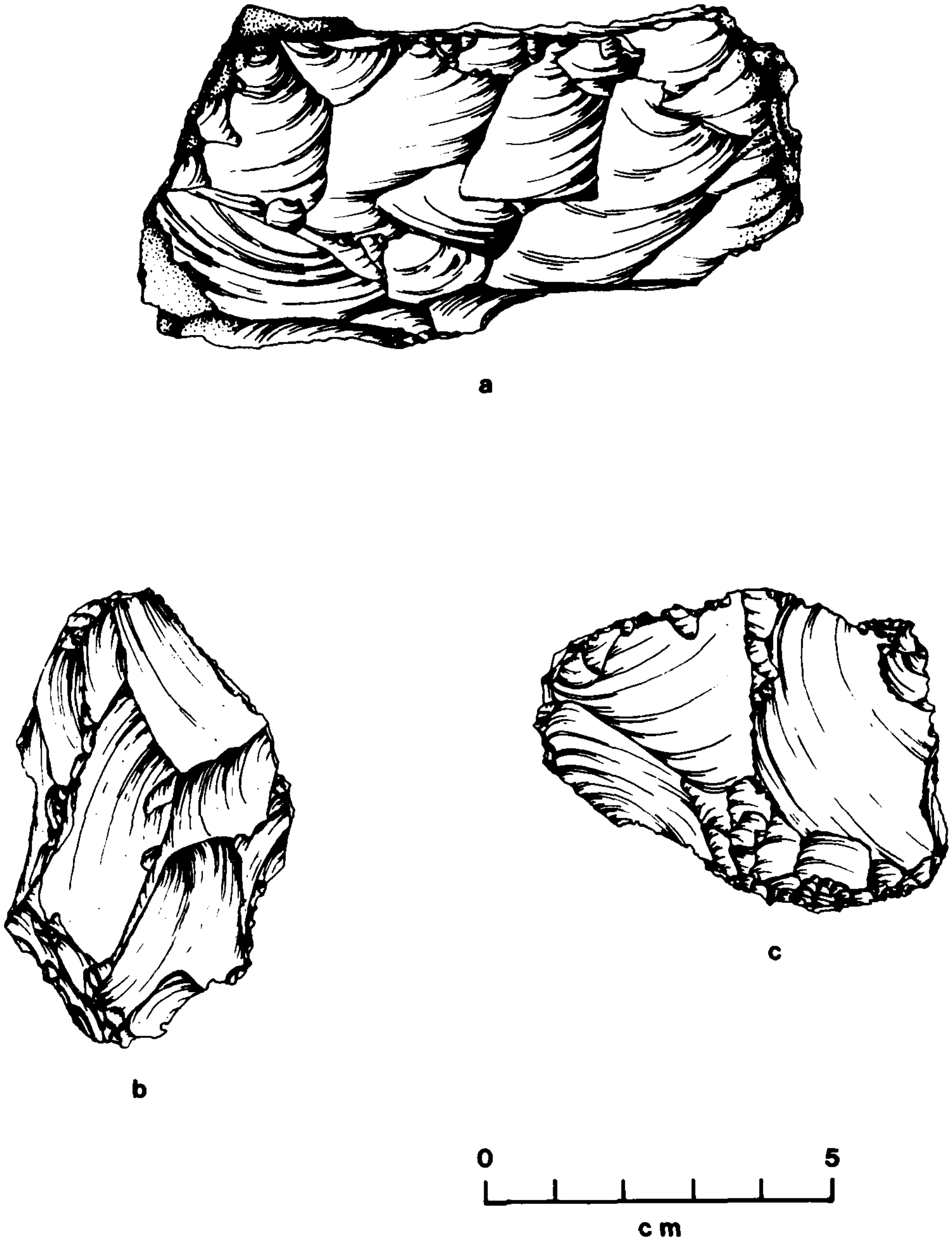


Figure 4.10. Chipped stone cores (14BU31): (a) double ended (A5001668-3), (b) polymorphic (A5001677-170), (c) bipolar (A5001667-10).

intersect at the core's midline; each cleavage face serves as the striking platform for the other detachment surface (Fig. 4.11). Discoidal cores are often confused with "crude" bifaces, especially when they occur as wasted or exhausted nuclei (a nucleus is a core from which no more suitable blanks can be detached). All of the above varieties are flake cores from which flake blanks were detached; none of them exhibited any blade detachment scars. A tabular core is a flat rectangular block from which tabloids were detached from one end. A tabloid is one kind of blank which has lateral sides (formed by the intersection of three surfaces) rather than edges (formed by the intersection of two surfaces). More will be said about blank varieties below.

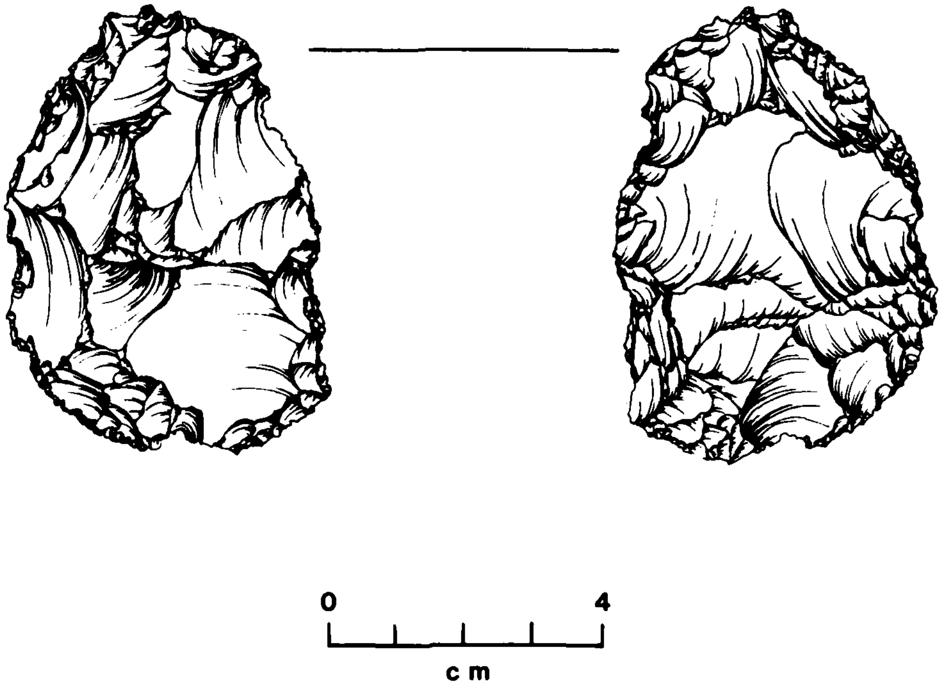


Figure 4.11. A discoidal core from 14BU31 (A5001677-545).

Polymorphic cores are by far the most common type on 14BU31 (Table 4.9). Discoidal cores are fairly frequent; other core types can only be characterized as rare. It can also be seen that there is no apparent association of core type with chert variety; this suggests that the various kinds of core could be made from any of the procured cherts. The raw material referred to as "light gray chert" is a descriptive label that represents a chert that is probably locally available; its exact source has not yet been determined. This particular chert is light gray in color, has a homogeneous medium texture, and many small, white fossil inclusions. It is thought to be a local Flint Hills type because it is a numerically frequent chert in all assemblages. The "miscellaneous" category is a residual group in which infrequent chert types of unknown significance and origin are lumped together. Specimens

in this latter group may represent exotic cherts obtained in interregional exchange systems or local types that were not much used. It would appear, however, from the counts presented in Table 4.9 that Florence chert was procured more often than other types.

An examination of core striking platforms reveals that prehistoric flint knappers treated striking platforms in a number of different ways prior to blank detachment. Observed striking platforms include: unprepared cortical, unprepared patinated, single faceted or plain, and multiple faceted. Dorsal reduction, the evening out of a striking platform edge, can occur with any of the striking platform treatments. Prepared striking platforms (faceted, plain, dorsally reduced) occur at about the same frequency as unprepared platforms (cortical and patinated).

The frequency of core fragments is interesting; cores made from Florence chert seem to have broken more often than cores made from other raw materials. The high breakage frequency of Florence cores can be accounted for by two possibilities: (1) they may have been reduced or worked by a knapping technique (not applied to other chert types) that caused more breakage or (2) Florence chert may break up more often than other cherts regardless of technique. Most cores and core fragments from the site were surface collected; two fragments were found in the test excavations.

Seven cores exhibit thermally induced color changes and have flake scars that are lustrous relative to surrounding surfaces. This indicates that these cores were heat treated before blanks were detached from them. Evidence for thermal alteration per se includes color changes, potlid scars, and an occasional chert specimen that has a crazed fracture pattern. Grosser (1970) subjected Florence chert to heat and was able to experimentally produce a color change. Florence and Foraker chert turn pink or red when exposed to sufficient heat; the light gray turns pink or darker gray. Some cherts do not react to heat by undergoing macroscopically visible changes, thus the data on thermally altered artifacts presented in this chapter are conservative. Only those specimens with observable color changes and/or potlid scars were counted as having been heated. The number of heat treated cores is very small, but thermal alteration is associated with no particular core or chert type. Four core fragments also show evidence of heat treatment. Since most of the heated cores are rather small, it is possible that they are exhausted nuclei that were used as hearthstones, boiling stones, or roasting pit heat sources. Such uses would have exposed them to sufficient heat to cause color changes. However, 4 of 7 specimens had blanks detached after they were heated, and there are even smaller cores in the collection that were not heated. This problem will have to be more fully explored with data from controlled excavations in undisturbed cultural deposits.

Chunks and shatter are pieces of chippable stone that exhibit the following attributes: (1) at least one freshly broken surface, (2) surfaces that intersect to form corners rather than acute edges, (3) no specific shape (they are polymorphic), (4) no striking platform, and (5) no cleavage faces (surfaces do not have flake scars). The differ-

ence between a chunk and a piece of shatter is size, the former is large and the latter small. They are combined for present purposes because they indicate the same sort of technological event, i.e., a piece of chert, such as a block of raw material or a core, collapsed under a too heavy impact. Chunks and shatter are technological waste and were usually discarded. Quite a few of these artifacts were retrieved from the site, most of them from the surface (Table 4.8).

A consideration of chunk and shatter data shows that Florence is the most frequent chert represented, followed by Foraker and a few rare specimens of other cherts. One new kind of chert is found here for the first time in the assemblage (Table 4.10). Westerville chert is not a

Table 4.10. Chunks and shatter (14BU31).

	Cortex		No Cortex	
Chert Type	Heated	Not Heated	Heated	Not Heated
Florence	10	42	7	19
Foraker	16	18	24	7
Light Gray	1	-	6	5
Westerville	3	2	-	1
Miscellaneous	-	-	2	-

local rock; its closest known source is 90 km. east of El Dorado Lake in Woodson County, Kansas. The chert is found in the Kansas City Group limestone; it has been studied and described by Reid (1978). Westerville is, therefore, an exotic chert in the El Dorado locality; its presence on 14BU31 suggests trade or contact with prehistoric groups in the eastern part of Kansas. Westerville chert turns red when exposed to sufficient heat.

Cortical chunk and shatter pieces are more common than noncortical specimens. This is the expected result if raw materials and cores are the artifacts that collapse. Thermally altered specimens are less frequent than unheated pieces. Since few cores were heated, the frequency of heated chunks and shatter seems a little too high. Many of the heated specimens may have been used as hearthstones, etc., rather than immediately discarded as waste. It should be mentioned that the presence of Westerville artifacts in this class indicates that fairly large pieces of that material were worked on the site. Westerville chert was not represented by artifacts in the core and selected raw material classes.

Prehistorically produced chunks and shatter were the most difficult artifacts to separate from naturally deposited gravels. The recognition problem was further complicated because natural gravel was often crushed or broken by farm machinery. Fortunately, terrace gravel was usually very small and covered with red or brown patina. Red patina is different from thermally induced red surfaces; no small fossils are visible on a patinated surface, whereas heat discolored surfaces do not mask fossil inclusions. Large pieces of river gravel are known to have been picked up and made into cores, so there was a certain amount of uncertainty with respect to separating cultural chunks and shatter having a patinated surface from natural specimens. This is another problem that can be resolved with excavated data.

Complete flakes, proximal flake fragments (broken pieces with a striking platform), and other flake fragments (broken pieces without a striking platform) are all treated here as debitage. This does not mean that all of this material is necessarily discarded waste; it does mean, however, that the distinction between by-products and potentially usable specimens is extremely difficult to make, particularly in a cultivation damaged surface collection. An examination of specimen counts shows that much surface material has been broken up by farm machinery. Total counts comparing surface collected artifacts with those found in test excavations illustrate this postdepositional breakage inference (Table 4.8); chunks and shatter appear to have the same high breakage rate in the plowzone.

Complete flakes (Table 4.11) exhibit three edges, a striking platform, and a ventral and dorsal surface. This class contains block preparation flakes, core trim flakes, blanks, core recovery flakes, and retouch flakes. Blanks are pieces detached from cores that may be utilized in unmodified form or retouched into unifacial and/or bifacial tools. There are three general blank types: (1) flake blanks, (2) blades, and (3) tabloids (tabloids were defined above when cores were discussed). Blades are detached from blade cores; they are long,

Table 4.11. Complete flakes (14BU31).

	Cortex		No Cortex	
Chert Type	Heated	Not Heated	Heated	Not Heated
Florence	2	13	3	14
Foraker	4	19	9	15
Light Gray	1	3	3	10
Westerville	4	-	-	-
Miscellaneous	-	5	-	7

have roughly parallel lateral edges, and the detachment scars on their dorsal surfaces are parallel to their long axes. Blades are struck from specially prepared and shaped cores; they represent a distinctly different aspect of lithic technology than do flake blanks and flake cores. Throughout this chapter, the term "flake" is used in its broadest generic sense to refer to any kind of detached chip; when blanks are under discussion, the term "flake blank" is used to avoid confusion between ordinary flakes and those thought to be possible blanks.

There is a tremendous size variation among the complete flakes recovered from 14BU31. Most of the cortical Florence specimens are large. Their dorsal surfaces are covered with cortex as are their striking platforms. These large and thick flakes may represent the splitting of a block of Florence chert to prepare a core's striking platform. Other large Florence flakes also have cortical surfaces, but are much thinner. The latter artifacts are trim flakes which were detached to remove cortical surfaces from a core. Some noncortical Florence flakes (Table 4.11) are large enough to have been usable blanks, but most are small retouch debris. Note that many Florence flakes are cortical, but not heated; this suggests that large tools, perhaps core tools, were made from Florence chert.

Complete flakes of Florence are about equal in frequency with Foraker flakes, however, more Foraker flakes have been heated. Cortical Foraker flakes are quite variable in size; some appear to be block splitting waste and core trim flakes. Most are small and are probably retouch by-products. Noncortical Foraker flakes are all rather small and are retouch debris. Most light gray flakes are not cortical; their size ranges indicate some may be blanks while others are small retouch flakes. The few light gray cortical specimens are large block preparation and core trim flakes. Westerville and miscellaneous chert flakes are all small retouch debris.

The same sort of general observations made for complete flake frequencies can be repeated for proximal flake fragments (Table 4.12) and other flake fragments (Table 4.13), except that there is less certainty

Table 4.12. Proximal flake fragments (14BU31).

	Cortex		No Cortex	
Chert Type	Heated	Not Heated	Heated	Not Heated
Florence	3	15	6	39
Foraker	7	16	21	24
Light Gray	1	2	3	19
Westerville	2	-	2	2
Miscellaneous	-	3	3	7

Table 4.13. Other flake fragments (14BU31).

Chert Type	Cortex Heated	Cortex Not Heated	No Cortex Heated	No Cortex Not Heated
Florence	3	35	10	74
Foraker	12	34	64	37
Light Gray	1	1	11	46
Miscellaneous	1	11	-	11

with respect to original size of these artifacts. Fragments of Florence chert are mostly cortical, but not heated, whereas Foraker flake fragments are mostly noncortical. The presence or absence of heat discoloration on Foraker specimens is about even. Florence and Foraker are the most common cherts represented; the light gray chert is not frequent. Westerville and miscellaneous chert varieties are present but rare. Striking platform treatments noted on complete flakes and proximal flake fragments include a greater variety than was observed on cores: unprepared cortical, unprepared patinated, plain, multiple faceted, ground and dorsal reduction. The debitage is a mixture of by-products produced by block preparation, core trimming and reduction, and tool manufacture.

Potlids are circular spalls that pop off the surface of a piece of chert exposed to high heat. Twelve potlids were recovered at 14BU31 (Table 4.8); there are 4 of Florence chert, 6 of Foraker, and 2 of light gray. These frequencies, though small, reflect the incidence of thermal alteration of chert varieties in the lithic assemblage accurately. Their presence demonstrates that chert was actually heated on the site. They are not necessarily a product of thermal pretreatment in a tool production sequence; a number of ways chert may have been subjected to heat was discussed above.

A resharpening chip is a flake or proximal flake fragment that exhibits heavy wear on the edge, and adjoining surfaces, formed by the juncture of its dorsal surface and striking platform. Nine such artifacts were found: 7 on the surface and 2 in the excavations (Table 4.8). All of them are flat, broad, and thin, which suggests that they were removed from bifaces. One specimen is of Florence chert, the rest are Foraker. Five Foraker chips have been heat altered; the Florence specimen was not heated. All nine resharpening chips show heavy edge rounding, polish, and a few stepped facets; this wear indicates that they were probably detached from a knife's edge.

There are two pieces of debitage that are unique enough to merit special attention. Two fragments of chipped shale were found in level 2 (20-30 cm.) of XU102. Both artifacts are flake fragments, but they

have well formed ventral surfaces with ripples (compression rings) and faceted dorsal surfaces. The shale is soft and can be scratched with a fingernail. Neither artifact seems to have been heated. Since these are the only two known artifacts made from shale, it is not certain that they are actually part of the chipped stone assemblage. It was noted earlier in this section that some pottery sherds had been tempered with indurated clay which resembles shale. The two apparent shale flakes may have been produced by pulverizing shale for pottery temper. This could be an interesting problem to monitor during future excavations and ceramic analyses on other Woodland sites.

A total of 42 chipped stone tools and tool fragments were recovered (Table 4.14); the only excavated tool is a uniface fragment that came from the plowzone of XU102 (Table 4.8). The collection contains two flake blanks that were used, but were not retouched in any way. Both artifacts are broken; one is made of Florence chert, the other is Foraker. The lateral edges of both specimens show edge rounding, bifacial

Table 4.14. Chipped stone tools (14BU31).

	Chert Type			
Tool Class	Florence	Foraker	Light Gray	Westerville
Utilized Blanks	1	1	-	-
Unifaces				
End Scraper	-	1	-	-
Side Scraper	2	1	2	-
Notch	-	-	1	-
Fragment	1	1	-	-
Bifaces				
Chopper	-	1	1	1
Celt	1	-	-	-
Projectile Point	2	6	-	2
Knife/Preform	3	2	4	-
Side Scraper	-	1	-	-
Fragment	-	4	3	-

step fracturing, and surface polish. The observed wear patterns indicate that they were used as knives (Fig. 4.12c). Neither was heat treated nor do they have cortex on any surface.

Many of the unifacially retouched tools have been damaged by farm machinery, but only two are so fragmentary that the tool class they belong to is indeterminate. One fragment is of heated Foraker chert; it is thick and may be a side scraper fragment. The second is a proximal flake fragment of Florence chert; unifacial retouch occurs on both lateral edges, so it may have been part of an end scraper. There is one complete end scraper in the tool collection; it is made of unheated light gray chert and has a cortical dorsal surface. Retouch flakes were driven off the dorsal surface at the distal end of a large flake. The working edge shows characteristic scraper wear, i.e., edge rounding and step facets.

Side scrapers are the most common kind of unifacially retouched tool recovered from 14BU31. The only side scraper that exhibits a thermally induced color change is also the smallest; it is made of Foraker chert. The other four were made from large flakes by retouching one or both lateral edges. All five side scrapers have working edges that exhibit the degradative wear expected on scrapers. All but one of these artifacts has been broken (Fig. 4.12b).

The notch, or concave scraper (Fig. 4.12a), was originally a single ended flake core made from light gray chert. The notch was formed by driving retouch flakes from the striking platform off one of the core's cleavage faces. The notch has a rounded working edge and step facets; it was used as a scraper.

Bifacially retouched pieces include choppers, a celt, projectile points, an end scraper, knives (and/or preforms), and some indeterminate fragments. Most of these artifacts are broken. The indeterminate fragments vary in thickness and edge regularity; they could be pieces from any of the tool types indicated in Table 4.14. Three fragments are of light gray chert, unheated, and four are of Foraker, two of which have been heated. Choppers are large heavy tools that have one bifacially retouched end and one unmodified end (Fig. 4.13b). There are examples made from Foraker, light gray, and Westerville chert, respectively; the Westerville chopper is the only complete artifact in this class. The two fragmentary tools were made from large flakes, whereas the Westerville chopper was made directly from a piece of procured raw material. On all three tools retouch scars are deep and variable in size; the retouched edges have not been regularized or evened, but present a scalloped appearance. The complete chopper, and one fragment, have crushed and step faceted working edges. The size, form, and edge wear characterizing these specimens indicate that they were made and used for heavy duty cutting, i.e., chopping. There is no evidence suggesting that the complete specimen was hafted; the thick distal end (opposite the working edge) indicates that the tool was probably hand held. None of these tools were heat treated.

The celt is long, narrow, and thick. The working end or bit is round and symmetrical, and is biconvex in longitudinal section; the

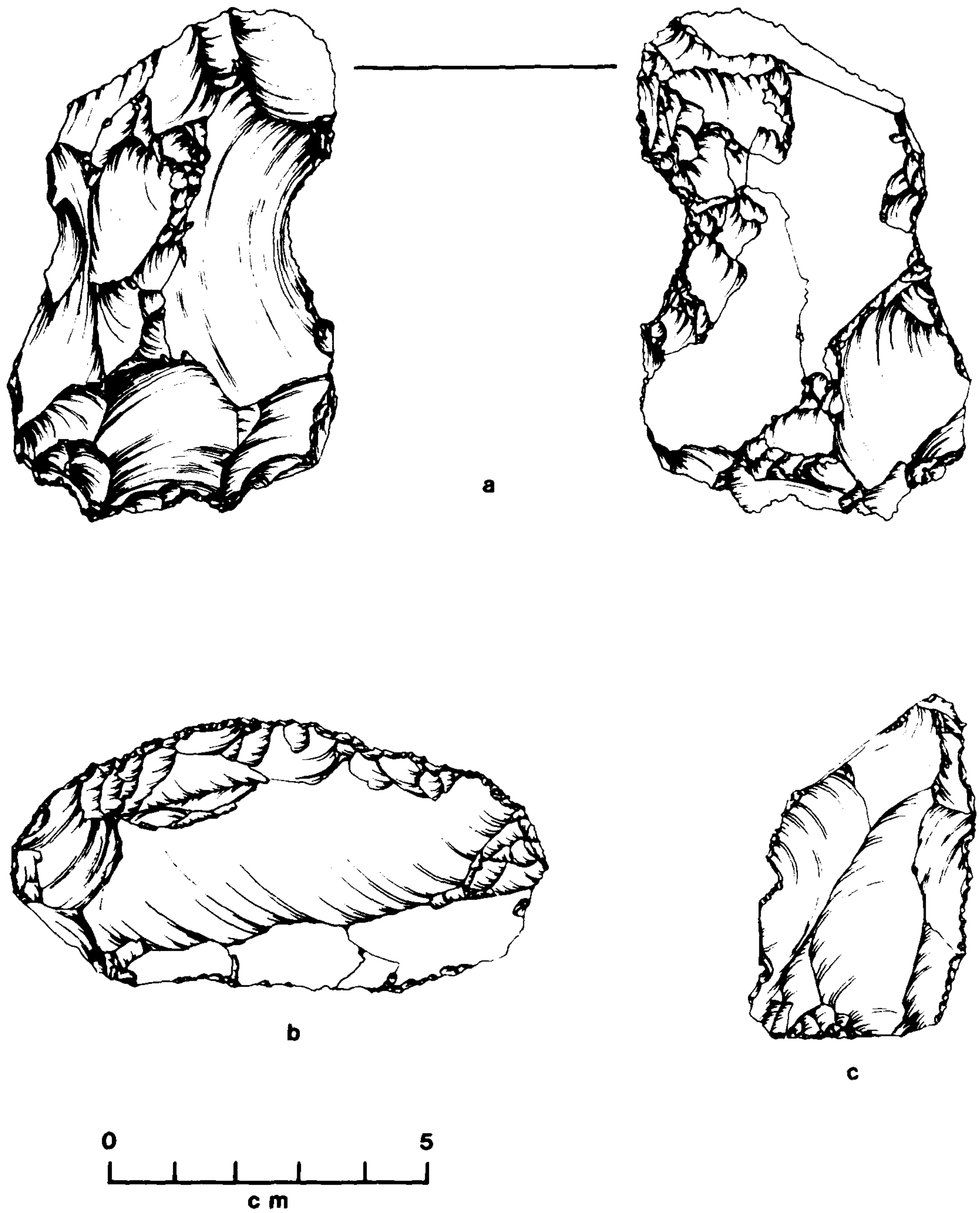


Figure 4.12. Chipped stone tools (14BU31): (a) notched core (A5001677-160), (b) side scraper (A5001667-3), (c) flake knife (A5001667-2).

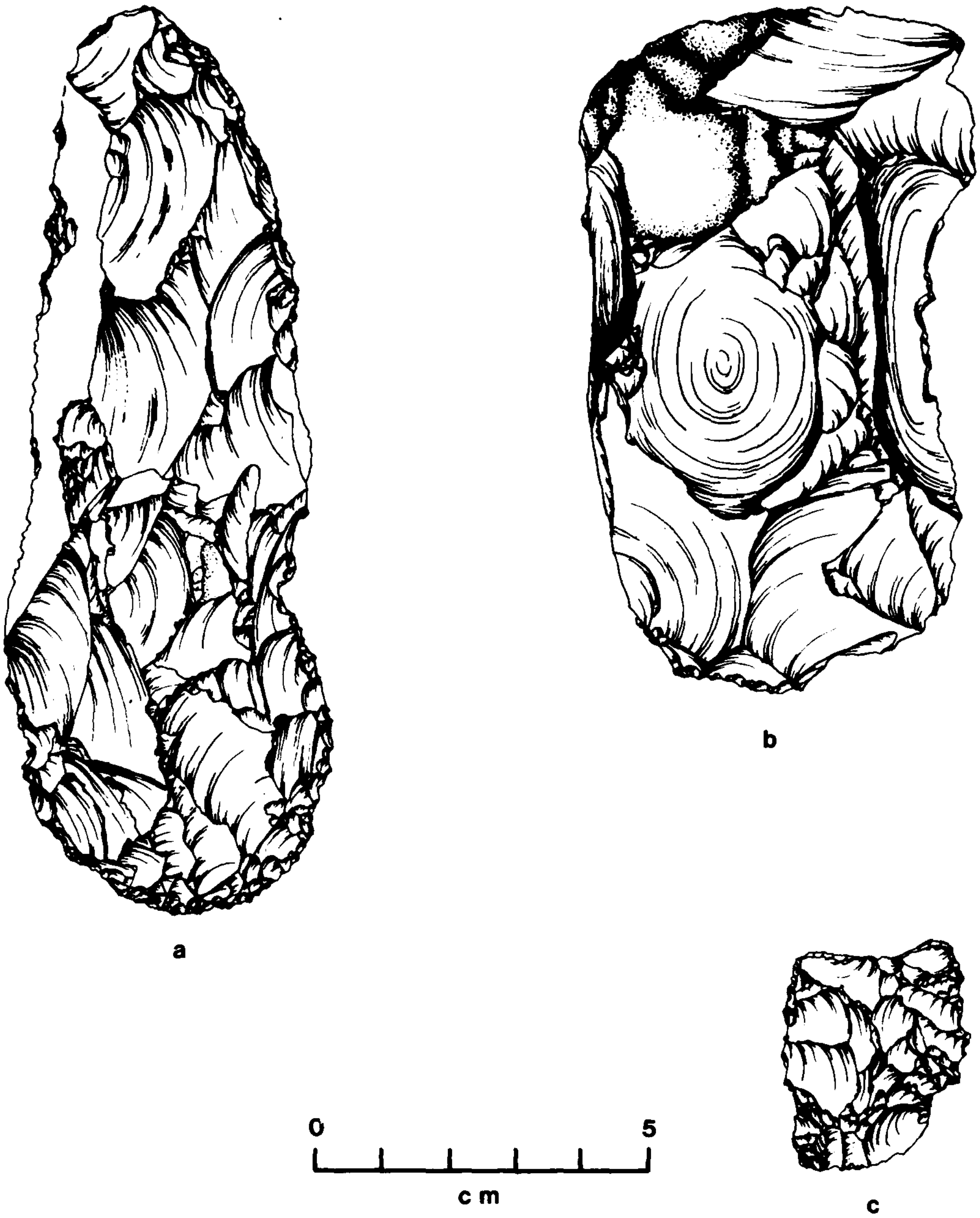


Figure 4.13. Bifaces from 14BU31: (a) celt (A5001667-16), (b) chopper (A5001667-17), (c) basal fragment of stemmed point (A5001667-21).

opposite end is narrower and more pointed (Fig. 4.13a). The tool is bifacially retouched on all sides except for that half of the right side nearest the pointed end; it is thus either unfinished, or that particular side was not retouched because the artifact was hafted. Evidence for hafting occurs on the tool's left side, opposite the unretouched portion of the right side, in the form of battering and grinding. The left side was probably retouched bifacially and dulled to narrow the tool's distal end so that it could be hafted more easily. Wear on the bit includes a rounded edge, slight polish, and step facets on both adjacent surfaces. The celt may have been a hafted woodworking tool; it was made of unheated Florence chert.

All stemmed and/or notched bifaces are counted as projectile points. Two of the ten artifacts are complete; the rest are tip, basal, and mid-body fragments. One blade and one base fragment are made of Westerville chert; both have been thermally altered. The basal fragment has slight shoulders and a stem with straight sides and base; most of the blade is missing (Fig. 4.13c). The other fragment has a pointed tip, but no stem or base. The two pieces are not portions of the same broken point; they do not fit together. Five other biface fragments are thin, narrow, and have straight, regular, retouched sides. All of them have breaks at their narrowest end and their widest end; they appear to be projectile point mid-body fragments from which the tips and stems are broken. Two are made of Foraker chert (one of which was thermally altered) and three are of Florence chert (none of which were heated). Three mid-body fragments exhibit impact fractures where tips used to be.

The point fragments described in the above paragraph are medium sized artifacts, i.e., somewhere between the smallest and largest complete specimens illustrated in Figure 4.14 (a,f). The smallest point has serrated blade edges and an expanding stem. It is almost certainly an arrow point. The largest point is more than three times the size of the arrow point; it is long and broad, and has a short stem with a slightly concave base. The big artifact is probably an atlatl dart point. Both projectile points can be described as generally triangular in outline and as having corner notches. They are made of Foraker chert; both were heat treated. Blade and stem edges of the two specimens were examined under a microscope for evidence of edge abrasion; neither shows any sign of having been used or ground. One bifacially retouched artifact is counted as a projectile point primarily because of its form. The specimen is an extremely thin heat discolored Foraker flake fragment that is triangular in shape (Fig. 4.14e). Its right side has been bifacially retouched, but with very little invasiveness; the left side is an unmodified distal edge and the base an unmodified right lateral edge of a flake. Apparently, a flake fragment, that fortuitously happened to be triangular in shape and about the right size, was picked up, retouched along one side (possibly to straighten that side), and used as an arrow point. The specimen is so thin that its base and left side could not have been further thinned or sharpened by bifacial retouch.

The next group of artifacts are thin, completely bifacially retouched along all edges (except where they are broken) and over both surfaces, and have regular, acute angled edges. The more complete speci-

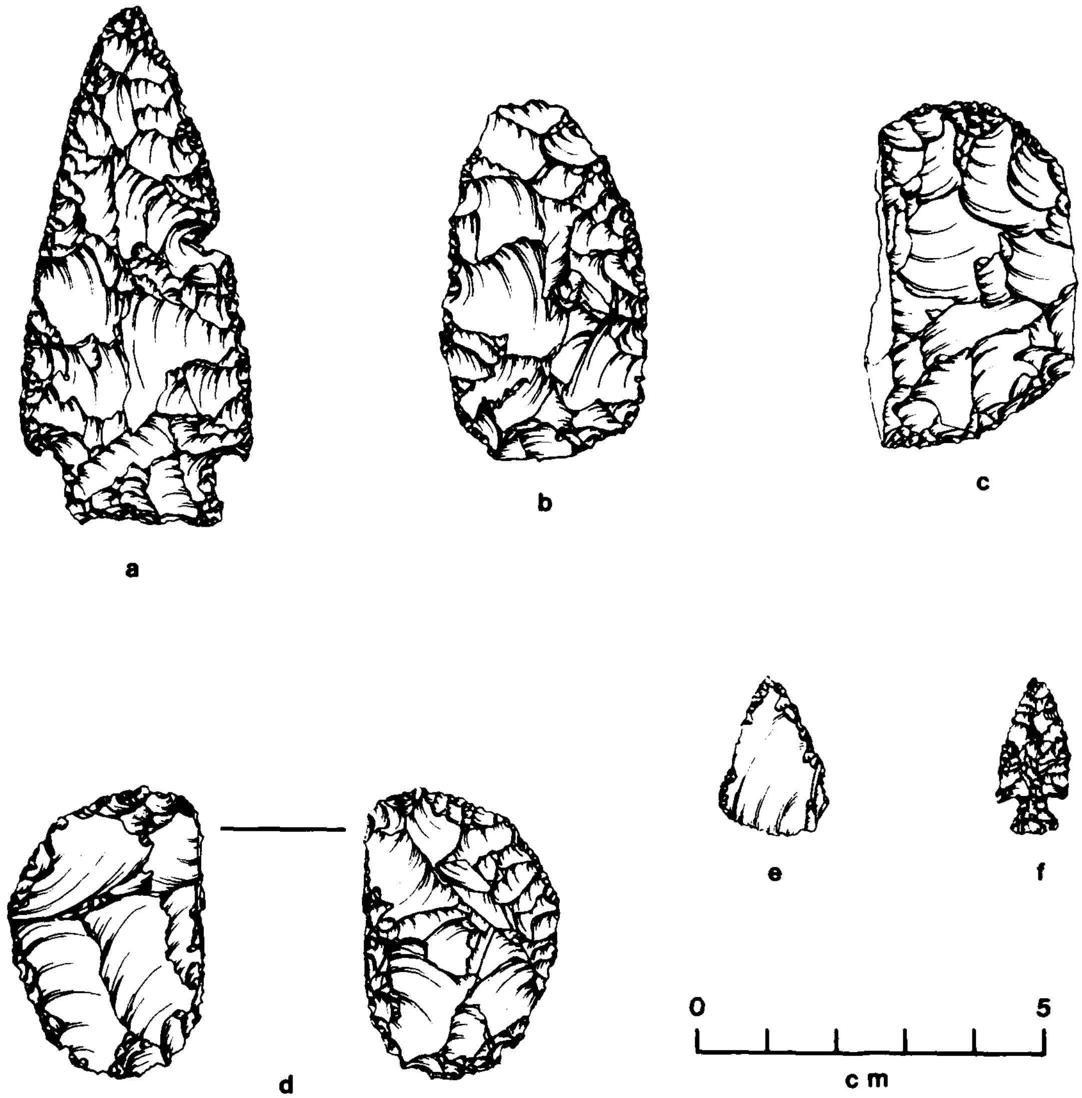


Figure 4.14. Bifacially retouched tools (14BU31): (a) dart point (A5001667-23), (b,c) knife/preform (A5001667-22, A5001677-43), (d) side scraper -(A5001677-61), (e,f) arrow points (A5001667-27, A5001677-662).

mens are ovate in shape (Fig. 4.14b,c). About half exhibit edge rounding, bifacial step facets, and slight polish along their retouched sides. The thinness, shape, and wear patterns on the specimens suggest they were used as knives. Other bifaces in this group have the same morphological features, but do not have worn edges. It is conceivable that some of the artifacts are bifacially retouched preforms that were to have been pointed and notched to make projectile points. Another possibility is that they are simply unused knives; preforms, of course, could have been used as knives. The group as a whole is presented in such a way as to indicate both possibilities in Table 4.14. It can be seen that all of them are made from local chert varieties. One fragment

placed in the group does not fit very well. It has the same edge wear, but is markedly thicker and narrower than the rest of the artifacts. Perhaps it is a narrow thick knife that had been resharpened often, but it could also be a lanceolate projectile point fragment. The ceramics discussed earlier and the projectile points described above, however, indicate that 14BU31 is a Woodland site. There is no reason to suggest a possible Archaic occupation on the basis of a small biface fragment.

The last bifacially retouched artifact shows how a broken but still usable tool fragment can be modified by additional retouch into a different tool form (Fig. 4.14d). The specimen in question seems to have been a thin biface, similar to those discussed above, that broke. Both surfaces and all edges, except for the break, are covered with retouch. However, on the side opposite the break, additional retouch flakes were driven off to form a steep edge. The modified side is now identical to the retouched side scrapers discussed in a previous paragraph, and, in fact, the working edge exhibits scraper wear, i.e., edge rounding and step facets on the newly retouched face. The only difference between this specimen and the other side scrapers is that the latter were made by retouching flake blanks and the former was made by retouching a thin biface fragment. The recycled biface is classified as a side scraper because the new working edge is parallel to the artifact's longest dimension.

It is instructive to note that seven of nine complete retouched tools were surface collected in 1967, ten years prior to the work reported here. This previous visit to the site produced three times as many complete artifacts in less than half a day than nearly three weeks of daily work on 14BU31. The difference in numbers of complete retouched tools clearly illustrates how collecting by relic hunters over a few short years can affect the data base and, hence, the interpretations, retrievable from a highly visible surface component.

Site Summary and Discussion

14BU31 is a small single component Woodland site situated on the surface of the Walnut River's first terrace. Surface debris is scattered over an area ca. 1.0 ha.; as much as 50% of the site may have been eroded away by the river. Hand excavated test squares and a series of backhoe trenches demonstrated that even though most of the cultural deposit has been destroyed by cultivation, there is a small area of intact subplowzone cultural horizon remaining in the northern half of the site. There are no deeply buried components at 14BU31. Three features were found and excavated; two were limestone filled basin-shaped pits that were interpreted as roasting pits, the third was an isolated ash lens interpreted as hearth cleaning debris.

Most of the prehistoric artifacts were collected from the site's surface. The recovery of burned earth and limestone, charcoal flecks, and the ash lens constitute evidence for the former presence of hearths. The two roasting pits, calcined bone, and charred seeds demonstrate that food was prepared, cooked, and consumed at the site. Probable

food items include fish, molluscs, rabbit, and seeds from goosefoot, knotweed, ragweed, and pigweed. In general, faunal and floral remains were better preserved in features than in general midden deposits. Pottery vessels may also have been involved in food preparation activities. The small sample of cord marked body sherds was tempered with limestone or indurated clay. Limestone may have been used in three different ways: (1) as hearthstones, (2) as radiant heat sources in roasting pits, and (3) as anvils on which to crush nuts. River rolled quartzite cobbles were probably used as pounders and hammerstones.

A study of the chipped stone assemblage showed that the prehistoric flint knapper procured and worked three types of locally available chert (Florence, Foraker, and light gray); an exotic chert (Westerville) not available in the immediate area suggests interregional exchange and contacts. Florence and Foraker chert were most frequently used to manufacture chert tools; other kinds of chert were used, but not very often. Six different kinds of core were prepared (polymorphic, discoidal, bipolar, single ended, double ended, and tabular) from which blanks were detached. A relatively small number of cores had been heat treated prior to blank removal. A study of the debitage showed that blocks and nodules of selected raw material, and even large pieces of river gravel, were prepared and made into cores. Blanks were retouched and shaped into unifacial and bifacial tools. The high frequency of thermally altered Foraker chert debitage indicates that blanks and preforms were heat treated. Chipped stone tools include blank knives, several kinds of scraper, choppers, projectile points, knives and/or preforms, and a celt.

The considerable quantity of chipped stone tools, and the presence of ceramics and facilities (such as roasting pits) suggest that 14BU31 was a base camp. No evidence for the former presence of houses was found. The tools, in general, appear to be compatible with hunting and gathering subsistence activities. Some tools, such as quartzite hammers, a limestone anvil, and a celt, indicate that the site's inhabitants carried out other tasks as well. Chert tools were manufactured, food items were processed (perhaps for storage in addition to immediate consumption), and, possibly, wooden implements were made. Ceramics may have been used to cook and store food; it is not known if pottery vessels were manufactured on the site. This list of artifact classes and inferred activities suggest that the occupation on 14BU31 was not transitory.

Even though there is an intact cultural deposit, and floral and faunal remains were recovered in flotation samples, most of 14BU31 has been destroyed by cultivation. Therefore, unless comparable Woodland sites can not be found with less disturbed deposits (which is unlikely), the site can be given a low priority status with regard to future salvage excavations. Given the time and resource constraints placed on future investigations, additional excavations on 14BU31 are not warranted.

14BU57

Description

The second archeological site tested in 1977, 14BU57, is located near the confluence of Satchel Creek with the Walnut River approximately 2.0 km. northeast of the dam's axis (Fig. 4.2). 14BU57 was found and tested in 1974, and surface collected in 1975. Neither of these earlier investigations have been reported in detail and as of 1976 the site's cultural affiliation had not been determined (Fulmer 1977; Leaf 1976a). The site was tested in 1977 because it lies within the confines of El Dorado Lake's multipurpose pool and because it was accessible during wet weather.

A reference point was established, and a contour map prepared with transit and metric leveling rod. The site map (Fig. 4.15) shows 1.25 m. of relief which trends downhill from the south bank of Satchel Creek to the southwest. 14BU57 lies on the surface of Walnut River's first terrace above floodplain; the Walnut is 0.1 km. west from the center of the indicated site boundaries. Satchel Creek has probably cut into the northeast portion of 14BU57, but a cutbank inspection failed to locate any eroding cultural debris. The creek is deeply incised and flows about 5.5 m. below the site's surface. Bounded by Satchel Creek to the east and north, and by the Walnut to the west, 14BU57 is on the east (left) bank of the Walnut and the south (left) bank of Satchel Creek. 14BU27 is located across Satchel Creek to the northeast of 14BU57, and 14BU30 is directly west across the Walnut River (Fig. 4.2).

The field in which the site lies appears to have been a barnyard. The area is surrounded by a barbed wire fence which also contains the remains of a barn and silo (Fig. 4.15). The presence of several large trees and the configuration of the relatively small fenced off area suggested that 14BU57 had not been plowed. The southwestern boundary of occupational debris roughly parallels a drainage feature that may have been altered slightly by former farm occupants to drain the barnyard and decomposition waste from the silo.

Even though surface visibility was obscured by heavy vegetation, a surface collection was obtained. Site boundaries illustrated in Figure 4.15 were determined by surface collecting and by the placement of posthole tests at 10 m. intervals radiating in the cardinal directions from the reference point. The small auger tests allowed a rapid and accurate determination of occupation distribution after it had been established in test squares that the site contained a well defined cultural horizon. The distribution of surface debris is coterminous with the extent of the buried occupation zone. Extant dimensions of the site are 90 m. north-south and 70 m. east-west; total observed surface area is 2,600 sq. m. or 0.26 hectare. The measured dimensions and surface area are probably too low. As noted above, Satchel Creek may have cut into the northeastern portion and there is some evidence that farm construction may have destroyed

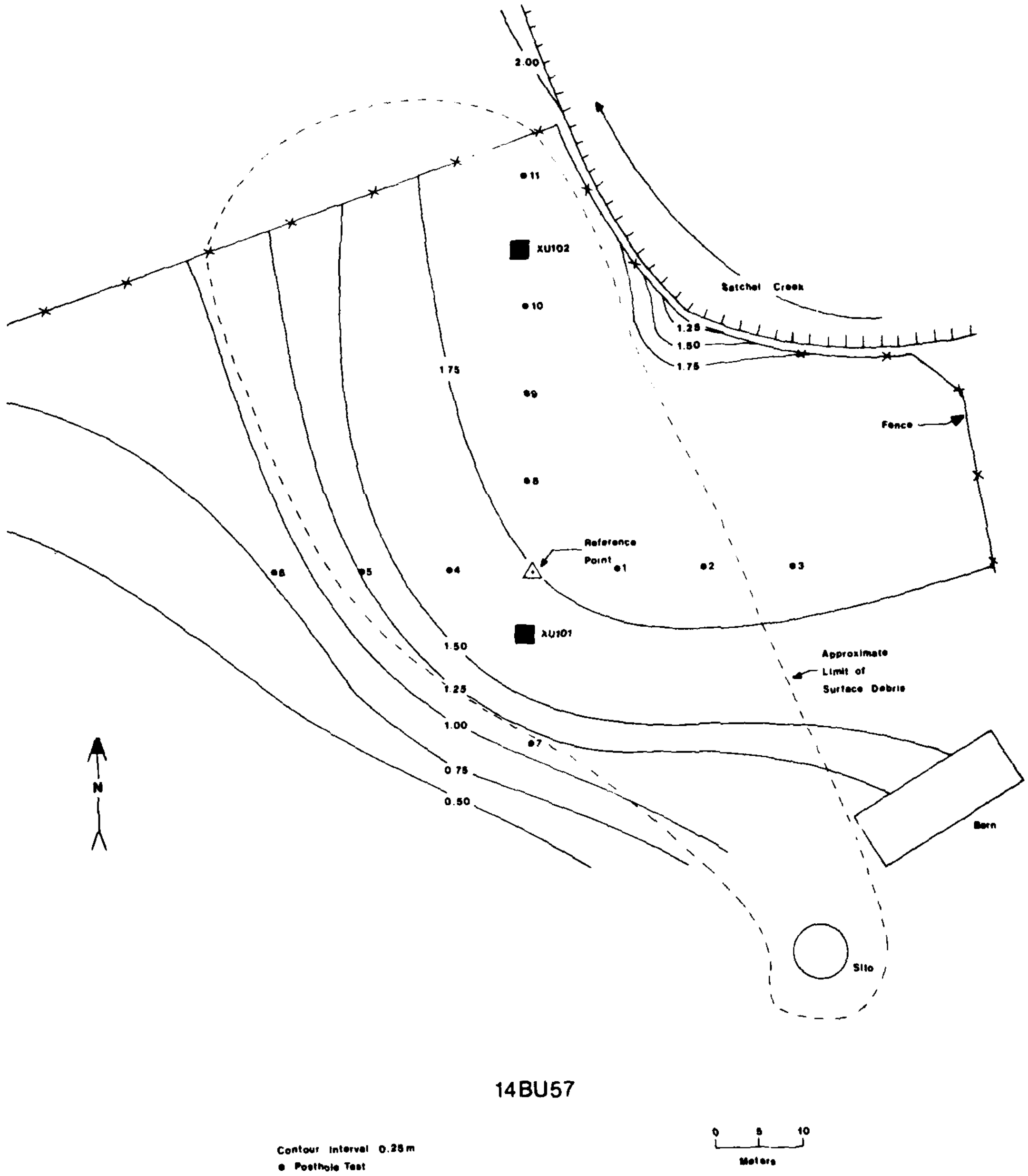


Figure 4.15. Contour map of 14BU57 showing the location of test excavations, posthole tests, and limits of surface debris.

southern portions of the site. It is not possible to accurately estimate how much destruction has occurred, but it could be as much as, or greater than, 50%.

Surficial debris was too obscured to warrant a grid controlled surface collection. The site was visible as a light scatter of chert and limestone, both of which were heavier on the slope of the drainage feature. This apparent greater density of surface material was clearly a product of natural erosion in conjunction with a lighter vegetation cover. No internal site areas exhibited high artifact densities that could be attributed to prehistoric human behavior.

Test Excavations

A two meter grid system was established for 14BU57 on the field map. The reference point was arbitrarily given the coordinates 100N100W to insure that all grid units on the site were located in the northwest quadrant. Four red monument hubs were placed in fence rows at the extremeties of north-south and east-west baselines where they were not likely to be disturbed. Two 2 by 2 m. square excavation units were staked out. One was placed at 92N100W and another at 136N100W; grid coordinates for each excavation identify its southeast corner. The two small test pits will be referred to as XU101 and XU102, respectively (Fig. 4.15).

XU101 was placed in the south-central part of 14BU57 where it was thought that the site had not been disturbed by outbuilding construction or gully alteration. Since surface inspection of the barnyard and other observations suggested that the site had not been cultivated, the test unit was dug as if no plowzone existed. The square was excavated with hand tools in 10 cm. levels relative to present ground surface; retouched tools, potsherds, and all other artifacts greater than 2 cm. in maximum length were plotted in three dimensions; and the backdirt was sifted through a ¼ inch mesh screen. A 17.5 l. (½ bushel) soil sample was saved from each excavated level for water flotation and screening. The floor of each finished level was scraped clean and examined for possible feature stains.

XU101 was dug to a depth of 50 cm. below surface. As can be seen from an inspection of Table 4.15, cultural debris was recovered from

Table 4.15. Depth distribution of artifacts recovered in XU101 (14BU57).

Level	Chipped Stone	Limestone	Bone	Pottery	Daub	Burned Earth	Historic
1	54	97	65	-	1	9	17
2	39	118	61	2	4	27	19
3	65	142	111	-	18	64	1
4	51	141	16	-	3	24	-
5	8	3	2	-	-	7	-

all five levels, but the relative frequency of artifacts dramatically decreased in level 5. These findings suggested that the bottom of the prehistoric deposit had been reached; two posthole tests augered through the 50 cm. floor for an additional meter of depth showed that no other buried occupations could be detected. The first four levels are all roughly similar in artifact content, i.e., they all produced numerous pieces of chipped stone, limestone, bone, and burned earth. Artifacts of historic origin were most frequent in the first 20 cm., pot sherds were scarce throughout, but the frequency of daub increased to level 3 and then decreased. Notice, however, that except for pottery and historic items, cultural debris is most numerous in levels 3 and 4 (Table 4.15). This observation receives support from the number of artifacts plotted in each of the four upper levels: 1 and 2 had 13 and 10 items, respectively, whereas 3 and 4 had 20 and 50 items plotted (Fig. 4.16).

When the west wall of XU101 was profiled, three strata were observed. Transitions from each stratum to the next lower were very subtle and difficult to see in the field, but were sharper and easier to determine on photographs and color slides depicting the profile. The plowzone is a dark gray loamy soil with a well developed ped structure; it extended from surface to a depth of 18-20 cm. Stratum 2 is a dark grayish brown loamy soil that started at the bottom of the plowzone and ended at 40-42 cm. below surface. Stratum 3 is a very dark grayish brown silty clay that extends from the bottom of stratum 2 to an unknown depth. Posthole tests drilled through this unit from the bottom of the excavation showed that it got sandier and less clayey with increasing depth (Fig. 4.17). The ped structure noted in the plowzone indicates that the site has not been cultivated for many years.

A consideration of the soil profile in conjunction with the depth distribution of artifact classes, demonstrates that 14BU57 contains an intact cultural horizon that has not been disturbed by cultivation. The occupation zone (stratum 2) is currently about 20 cm. thick (20-40 cm.). Cultivation disturbed the top 20 cm. of the site (stratum 1, 0-20 cm., plowzone), but debris densities in the first two excavation levels indicate that the occupation zone may possibly have extended continuously from the surface to a depth of 40 cm. If the uppermost portion of the occupation zone had been truncated and mixed with a soil zone that did not contain cultural debris, one would expect artifact frequencies in levels 1 and 2 to be much lower than they are (Table 4.15). The relatively uniform debris frequencies could also have resulted from the mixing of a surface component with a buried component. This latter alternative will emerge as a possible problem when artifact analyses are discussed below.

XU102 was placed in the northeastern portion of 14BU57 near the creek bank (Fig. 4.15). This second test pit was designed to check on the continuity and depth of the intact occupation zone at a locus on the site higher in elevation than XU101 and further away from outbuildings and the drainage feature. XU102 thus allowed a simultaneous evaluation of the impact of runoff erosion and farm construction on

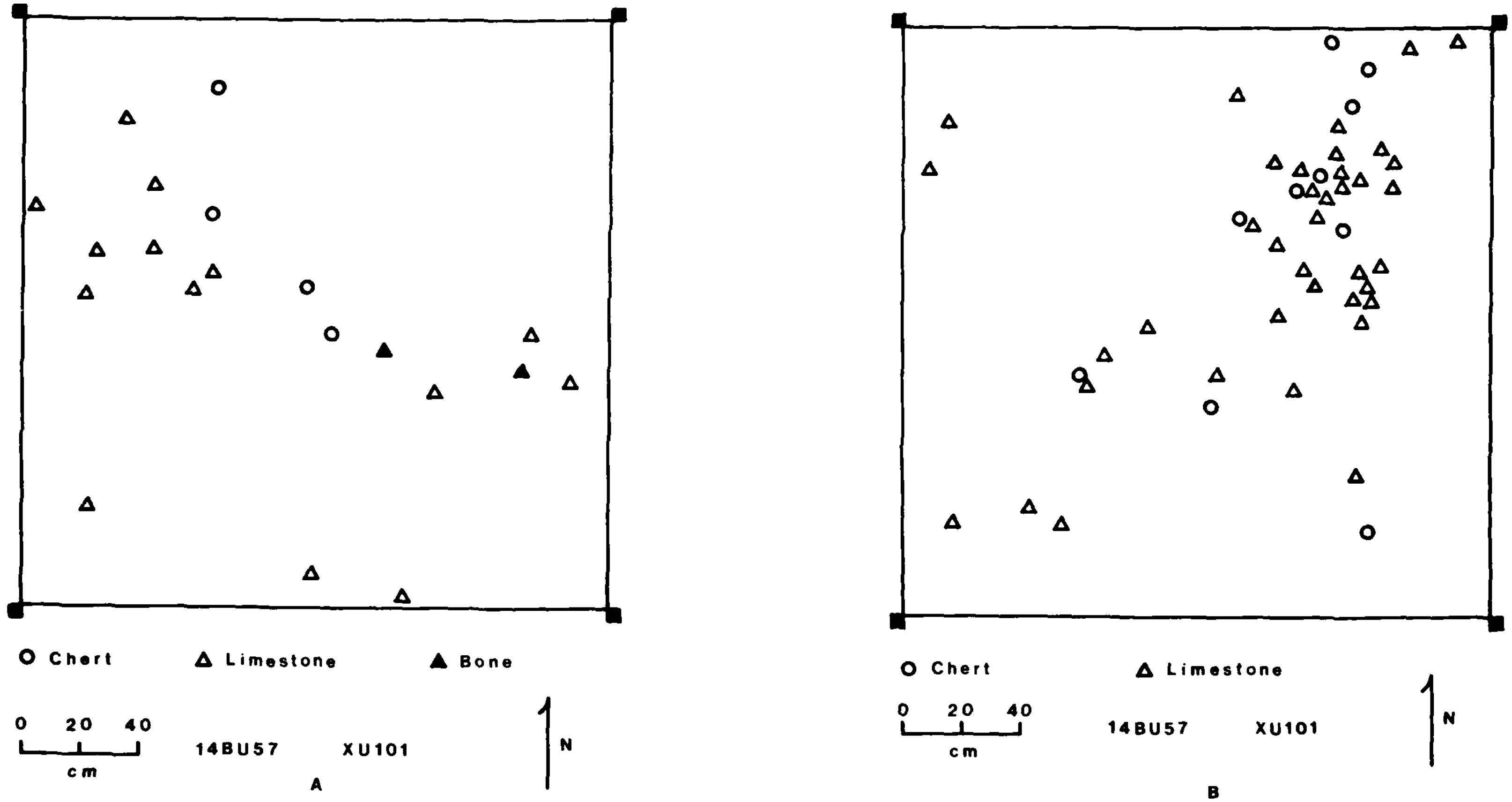


Figure 4.16. Horizontal distribution of plotted artifacts in XU101 (14BU57): (a) level 3 (20-30 cm.), (b) level 4 (30-40 cm.).

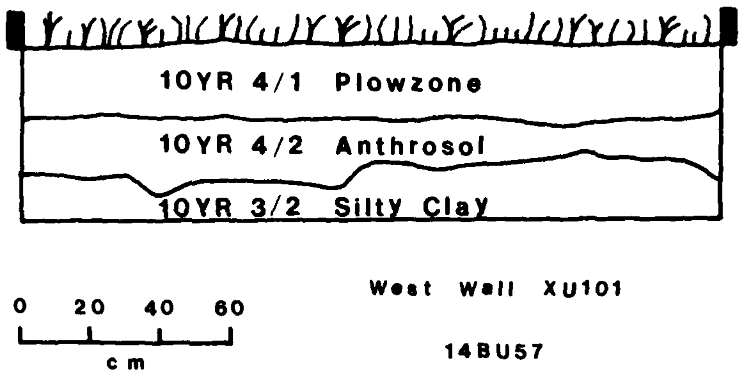


Figure 4.17. West wall profile from XU101 (14BU57).

the cultural horizon. Excavation techniques were the same as those used in XU101, except that the plowzone (level 1) was removed as a single 20 cm. unit and XU102 was dug to a total depth of 60 cm. below present ground surface.

Depth distribution of artifact classes in XU102 is similar to that discussed above for XU101 (Table 4.16). Pieces of chipped stone,

Table 4.16. Depth distribution of artifacts recovered in XU102 (14BU57).

Level	Chipped Stone	Limestone	Bone	Pottery	Daub	Burned Earth	Historic
1	98	55	45	-	8	42	10
2	60	26	15	1	12	51	-
3	170	105	17	1	11	106	-
4	52	20	3	-	4	71	-
5	1	4	-	-	-	3	-

limestone, bone, and burned earth are numerous in the top four levels; historic artifacts were recovered only in the plowzone; pottery is scarce; and daub is most frequent in the subplowzone occupation zone. The undisturbed cultural horizon is thicker and deeper in XU102; it extends from the plowzone bottom (level 1, 0-20 cm. below surface) to the bottom of level 4 (50 cm. below surface) and is thus 30 cm. thick. Level 5 (50-60 cm.) was essentially devoid of artifacts and

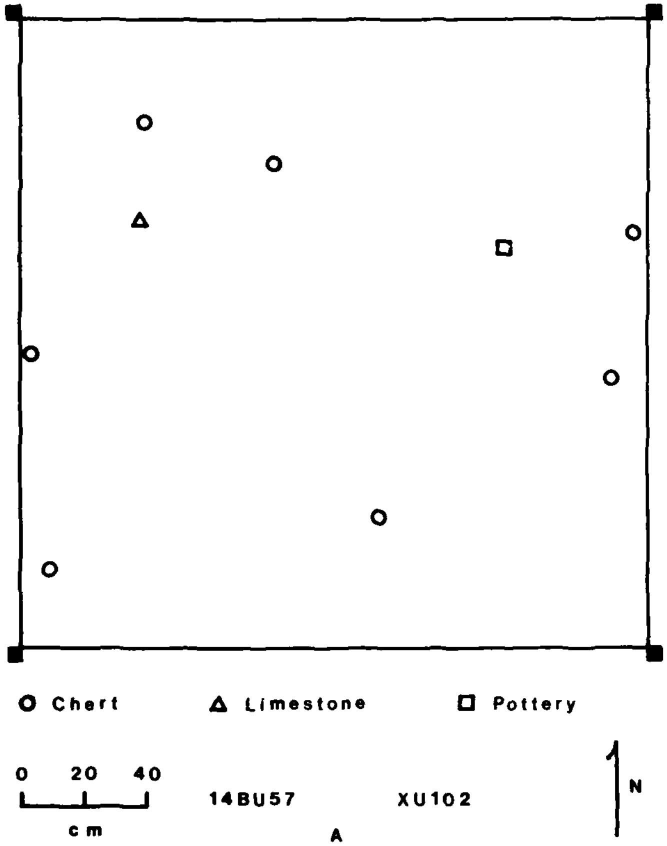
demonstrates that the excavation had gone through the bottom of the cultural horizon. The soil profile recorded for XU102 is similar to Figure 4.17, except that stratum 2, the anthrosol, extends to a depth of 50 cm. before stratum 3 begins.

A comparison of the results obtained from XU101 and XU102 indicates that there has been more disturbance of the occupation zone near XU101 than near XU102; it seems likely that a combination of plowing, erosion, and farm construction in the southern portion of 14BU57 is responsible for the damage. The two test pits, as well as the posthole tests, demonstrate that there is an intact and continuous occupation zone on the site. That there may be some functional differentiation within the cultural horizon is suggested by a comparison of the artifact classes plotted in XU101 (Fig. 4.16) and XU102 (Fig. 4.18). Most of the artifacts plotted in XU101 are pieces of limestone, whereas most of the specimens plotted in XU102 are chipped chert. No storage pits, postmolds, fire pits, or any other kind of feature, were found in either test pit. The excavated portion of the midden seems to represent areas of trash disposal where more limestone got dumped in one area (XU101) and more chert in the other (XU102). Plotted artifact distributions are random, i.e., there are no apparent meaningful patterns, except for the distinct concentration of plotted material in the northeast corner of XU101, level 4 (Fig. 4.16). If these two tested areas are in fact trash disposal locales, then there should be areas on the site from which trash was collected and carried away (such as houses or cooking areas).

Artifact Analyses

The descriptions, discussions, and inferences drawn from analyses of the artifact collection retrieved from 14BU57 are complicated by the possibility that the site may contain two prehistoric components. Projectile points attributable to Plains Village components were collected from the site's surface and a projectile point associated with Woodland components was found in the undisturbed occupation zone. Thus, in addition to the usual analytical tasks reserved for this section, there will be an attempt to elucidate whether: (1) artifacts recovered from the surface and plowzone represent a mixture of Plains Village and Woodland debris, or (2) artifacts recovered from surface and plowzone are disturbed Woodland materials only. If it can be supported, the latter alternative requires a rethinking of the taxonomic status of "Woodland" and "Plains Village" as well as current notions of culture history and culture change in the project area.

Prehistoric artifacts from 14BU57 represent nine analytical classes: (1) burned earth, (2) daub, (3) pottery, (4) sandstone, (5) limestone, (6) quartzite, (7) bone, (8) charcoal, and (9) chert. Burned earth, daub, and pottery are similar in that they are varieties of heat-hardened soil. Ceramics are the easiest to identify because sherds are generally tempered with some aplastic material, such as limestone, and they often have decorated surfaces. Burned earth and



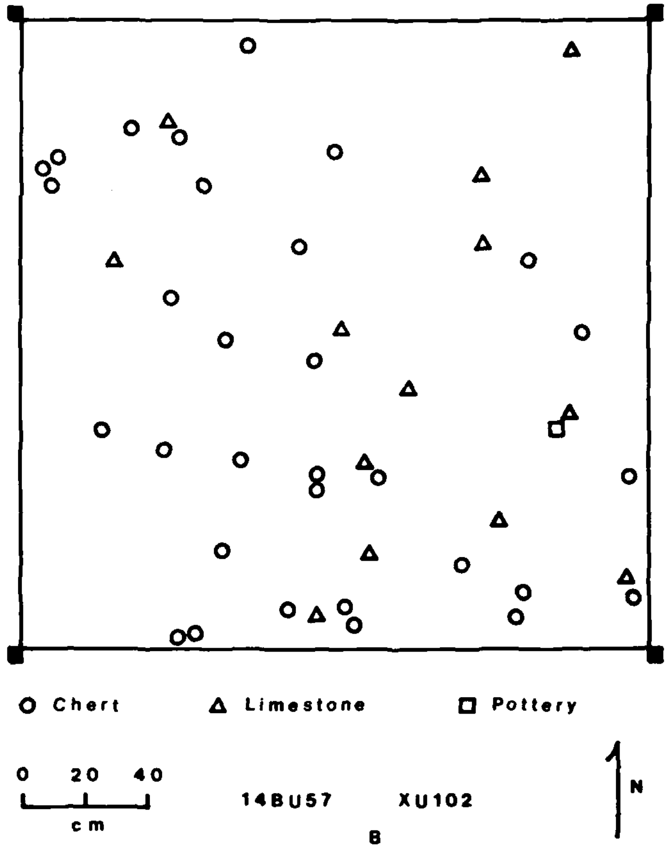


Figure 4.18. Horizontal distribution of plotted artifacts in XU102 (14BU57): (a) level 2 (20-30 cm.), (b) level 3 (30-40 cm.).

daub are neither tempered nor decorated. Daub is a piece of burned earth which exhibits grass, twig, or pole impressions, or a single smoothed surface. This distinction is necessary because of the inferences that may be made upon the recovery of daub and/or burned earth. Daub indicates the former presence of a structure, such as a house, built of poles and twigs or grass which was plastered with mud or moist clay; the plaster was hardened by sunshine or burning of the structure and recovered as daub. Burned earth indicates the former presence of fire on the earth's surface, such as a hearth; it can also be produced naturally during forest or prairie fires. When burned earth and daub are both recovered from an archeological site, the proportion of burned earth will be inflated because pieces of daub may have broken apart in such a manner as to produce fragments without the distinguishing criteria for daub.

The distribution and counts of daub, burned earth, and pottery are shown in Table 4.17. Burned earth was found in both test pits,

Table 4.17. Distribution of burned earth, daub, and pottery (14BU57).

	Burned Earth	Daub	Pottery
Surface Collection	-	-	2
XU101			
Plowzone	37	4	2
Subplowzone	97	21	-
XU102			
Plowzone	42	8	-
Subplowzone	231	27	2
Site Totals	407	60	6

and was more frequent below the plowzone in each case; daub exhibits the same pattern. No daub or burned earth was collected from the site's surface. The rise in specimen count with increasing vertical depth can be explained as a result of preservation differentials. Pieces of burned earth and daub exposed on the surface were affected by the mechanical action of cultivation and weathering to the extent they were either destroyed or made unrecognizable. Pieces in the plowzone were disturbed by cultivation, but some survived and were recovered; while those in the undisturbed occupation zone survived in greater quantities because they were least affected by weathering

and cultivation. The distribution patterns of burned earth and daub, therefore, can not be ascribed to their presence in one component and absence from a second; the vertical frequencies do not indicate how many components are present on 14BU57.

Pottery was recovered from surface, plowzone, and subplowzone contexts (Table 4.17). The sample is small (n=6) and has an ambiguous distribution. Two specimens collected from the surface are body sherds. One sherd has a brown exterior surface marked with smoothed-over cord-wrapped paddle impressions, the interior surface is brown and smoothed, core color is dark gray, and it is tempered with limestone. The second body sherd is identical to the first in all respects except that it was tempered with indurated clay. Two specimens (a fragment and a lip sherd) were found in XU101, level 2 (10-20 cm.). The fragment has no intact sherd surface, but is brown in color and tempered with indurated clay. The lip sherd has brown surfaces, a dark gray core, smoothed interior and uppermost surfaces, a smoothed-over cord-wrapped paddle impressed exterior surface, and is tempered with indurated clay. Two additional specimens were found in subplowzone contexts of XU102: a fragment in level 2 (20-30 cm.) and a fragment in level 3 (30-40 cm.). Both fragments are limestone tempered and have smoothed interior sherd surfaces.

It is instructive to note that only sherd fragments (specimens which do not exhibit intact exterior and/or interior sherd surfaces) were recovered from the undisturbed occupation zone. The more complete artifacts, two body sherds and a lip sherd, were either found on the surface or in the plowzone. The exterior surfaces of all three sherds are cord marked; one is tempered with limestone, two with indurated clay. The contextual distribution of ceramic tempers is shown in Table 4.18. Half of the pottery sample is tempered with limestone and half

Table 4.18. The occurrence of pottery temper in relation to context of recovery (14BU57).

	Limestone	Indurated Clay
Surface Collection	1	1
Plowzone	-	2
Subplowzone	2	-

with indurated clay; there is no stratigraphic separation of temper types. The uniformity of observable exterior surface treatments (cord marking) and the contextual nonexclusion of temper varieties suggest that the ceramics can be attributed to a single prehistoric component. Cord marked sherds tempered with limestone or indurated clay are common on Woodland sites in the El Dorado locality (Fulmer 1976, 1977; Grosser 1970; Bastian 1978). The ceramic evidence, then, indicates that there is a single Woodland component on 14BU57; but, the sample is small and two-thirds of it was recovered from contexts disturbed by cultivation.

The sample of sandstone artifacts is also small (n=2). One piece was collected from the site's surface. It is unburned and has marks on one surface made by a metal tool; this specimen can be associated with historic occupation of the surrounding farm. The second specimen was recovered from the plowzone of XU101 (level 2, 10-20 cm.); it is unburned and has no shaped or modified surface. Since 19 historic artifacts were found in the same level, it is not known if the second sandstone fragment is associated with historic or prehistoric occupation of the site. Sandstone artifacts were not found in the undisturbed prehistoric occupation zone.

Limestone is the second most numerous artifact category; the total sample comprises 790 specimens all of which weigh a total of 5,989.5 gm.(13.2 lbs.). Counts, weights, and the distribution of burned versus unburned limestone are presented in Table 4.19. Limestone was not collected from the site's surface in a systematic manner; the surface sample was taken opportunistically and is, therefore, not representative of the surface population. The data do indicate, however, that burned limestone is less frequent than unburned limestone. This observation is corroborated by an inspection of the counts for excavated items; burned limestone is less frequent in all contexts than unburned limestone. Table 4.19 also shows that both kinds of excavated limestone increase in frequency with increase in vertical depth. Both distribution patterns, i.e., the greater frequency of limestone with increase in vertical depth and the greater frequency of unburned pieces relative to burned pieces, can be attributed to the differential preservation processes noted above for burned earth and those discussed earlier for limestone at 14BU31. Briefly, it can be argued that the deeper a piece of limestone was buried the better it was protected from the destructive agencies of cultivation and weathering, and that burned limestone is less resistant to those destructive processes than unburned limestone. This means, quite simply, that the distribution patterns in question can not be a result of prehistoric human behavior.

Differential prehistoric utilization of 14BU57 may account for the greater total amount of limestone recovered in XU101 relative to XU102. It was noted in the previous section that most of the plotted artifacts found in XU101 were pieces of limestone, whereas most of the artifacts plotted in XU102 were chipped stone (Figs. 4.16 and 4.18). The counts in Table 4.19 show that more limestone was found in XU101 than in XU102; these data are consistent with the interpretation that the tested portions of 14BU57 are areas of trash disposal where more limestone was dumped in one locale (XU101). Furthermore, the large amount of limestone recovered from the excavations suggests that limestone may have been used to pave or outline hearths, or as radiant heat sources in roasting pits; but, there is no direct evidence for either use in the form of features. As mentioned above, limestone was crushed and used to temper clay for pottery manufacture.

A quartzite hammerstone was found in the occupation zone of XU101 (level 4, 30-40 cm.). The artifact is a utilized river-rolled cobble which weighs 120.5 gm.; its dimensions are 49.8 mm. by 49.8 mm. by 35.1 mm. In overall shape it resembles a rounded pyramid; two corners

Table 4.19. Limestone counts, weights, and distribution (14BU57).

	Number	Weight (gm.)
Surface Collection		
Burned	24	599.4
Not Burned	53	1714.5
XU101, Plowzone		
Burned	7	6.4
Not Burned	208	648.6
XU101, Subplowzone		
Burned	57	657.5
Not Burned	231	1657.9
XU102, Plowzone		
Burned	2	7.5
Not Burned	53	79.2
XU102, Subplowzone		
Burned	29	138.2
Not Burned	126	480.3
Site Totals		
Burned	119	1409.0
Not Burned	671	4580.5

and one lateral surface are battered and crushed from hammering. The hammerstone is probably too small to have been comfortably used to crush limestone or smash bone (see below), but would have been quite suitable for chipping chert. Two quartzite flakes were recovered from the occupation zone of XU102 (level 3, 30-40 cm.). The flakes are unbroken, small, and made of a nondescript, finely textured brown quartzite. This material is markedly different from the coarse red quartzite cobble used as a hammerstone. The flakes indicate that prehistoric occupants of 14BU57 were able to obtain nonlocal quartzite

suitable for the manufacture of chipped stone tools. Even though the sample is small (n=3), the evidence shows that quartzite was used to percuss other materials and knapped to make tools.

Animal bone was recovered in all levels (plowzone and subplowzone/ anthrosol) of the two test pits (Table 4.20). This faunal sample (n=337, total weight 446.6 gm.) is the largest bone collection obtained from any prehistoric site tested in 1977. A comparison of counts and weights, however, shows that individual pieces of bone are small; the average specimen weighs only 1.3 gm. Except for the identified skeletal elements discussed below, most of the specimens are recognizable as fragments of large mammal long-bones. Many of the fragments have fracture patterns associated with the breaking of green bone; fracture patterns on green (or fresh) bone are distinguishable from breakage patterns on old bone (Bonfield and Li 1966; Miller 1975;

Table 4.20. Counts, weights, and distribution of excavated bone (14BU57).

	Number	Weight (gm.)
XU101, Plowzone		
Burned	20	7.4
Not Burned	106	58.5
XU101, Subplowzone		
Burned	37	24.1
Not Burned	94	52.5
XU102, Plowzone		
Burned	1	0.7
Not Burned	44	290.9
XU102, Subplowzone		
Burned	8	3.8
Not Burned	27	8.7
Site Totals		
Burned	66	36.0
Not Burned	271	410.6

Bonnichsen 1973). These observations suggest that the long-bones of large mammals (such as bison or deer) were smashed up to extract marrow and grease (Vehik 1977). Bone meal (numerous fragments of bone) can also be produced by domestic dogs or wild scavengers gnawing on discarded bone, and, possibly, by general butchering or garbage disposal. These activities may account for some of the bone fragments, but not all of them. Grease and marrow can be extracted from smashed bone by boiling or baking. Notice that roughly 20% of the sample is charred or calcined (Table 4.20); boiling, of course, does not burn bone. Furthermore, 76% of the bone was recovered from XU101, where a large amount of limestone was interpreted as the product of prehistoric trash disposal. If the limestone was used in hearths and/ or roasting pits, and the hearths or roasting pits were used to extract bone grease or marrow, then one could reasonably expect the debris and garbage produced by such activity to be gathered up and disposed of together. The greater frequency of bone fragments and limestone found together in XU101 versus XU102 supports the interpretations. It should also be mentioned that none of the bone fragments exhibited any cuts, grooves, or modifications which could be attributed to animal gnawing. From the data and associations presented above, it can be tentatively concluded that the prehistoric occupants of 14BU57 smashed up mammal bone to extract marrow or grease, and that the extraction process included boiling and/or baking.

Identified skeletal elements, and their provenience within the site, are listed in Table 4.21. There are variable degrees of taxonomic assignment; many of the elements did not have the requisite intact diagnostic characters which allow generic or specific identification. Thus, one specimen is identified as "probably bird" and others as "turtle"; by "small mammal" is meant an animal approximately the size of a rabbit, a "medium mammal" would be roughly the size of a dog or coyote. Generic and specific identifications were made by comparing the archeological specimens to the osteological collections housed in the Division of Mammology, Museum of Natural History, University of Kansas.

The fauna listed in Table 4.21 include: turtle, bird, eastern mole (Scalopus aquaticus), vole (Microtus spp.), squirrel (Sciurus spp.), small mammal, medium mammal, bison (Bison bison), and deer (Odocoileus spp.). Identified bones found in excavated plowzone levels may be intrusive if living representatives of those animals are found in the local fauna. This means that the bird and squirrel elements may not be associated with prehistoric occupation. The bison ulna is probably prehistoric. Bison are not presently part of the local wild fauna; they were extirpated in Kansas before 1889 (Hall 1955). Eastern moles and voles are burrowing animals (Hall 1955), so their remains may be intrusive no matter where they are recovered in an excavation. The remains of turtle, small mammal, medium mammal, and deer were taken from the occupation zone and can be accepted as prehistoric food remains with reasonable confidence. The bone meal discussed earlier probably came from the smashing of deer and bison bone. There are two species of deer (white-tailed and mule) known to have inhabited the El Dorado area in the recent past; the deer molar fragment found in XU102 is not sufficient to distinguish which species it represents.

Table 4.21. Identified skeletal elements and their context of recovery (14BU57).

XU101	
Level 2, 10-20 cm.	
	1 long bone fragment, probably bird
	1 rib, small mammal
Level 3, 20-30 cm.	
	3 carapace fragments, turtle, 2 charred
	1 right humerus, *Scalopus aquaticus*
	2 caudal vertebrae, medium mammal
	1 femur fragment, small mammal
Level 4, 30-40 cm.	
	1 rodent mandible, no molars, probably *Microtus* spp.
XU102	
Level 1, 0-20 cm.	
	1 lower right incisor, *Sciurus* spp.
	1 olecronon process, right ulna, *Bison bison*
Level 2, 20-30 cm.	
	3 humeri, 2 left and 1 right, *Scalopus aquaticus*
	1 mandible fragment, *Scalopus aquaticus*
	1 right ulna, *Scalopus aquaticus*
	1 molar fragment, *Odocoileus* spp.
	1 scapula fragment, distal end, medium mammal
Level 3, 30-40 cm.	
	1 cervid tooth fragment, probably *Odocoileus* spp.
	1 caudal vertebra, medium mammal

The faunal data suggest that turtle, small mammal, medium mammal, bison, and deer were food items consumed at 14BU57; bird, squirrel, eastern mole, and vole are possible, but unconfirmed, subsistence items.

Flecks and small pieces of charcoal too small to recover were observed in each level of the excavation units when they were dug. A 17.5 l. (½ bushel) soil sample was saved from each finished level and processed by flotation and waterscreening. This work recovered only 0.5 gm. of charcoal and two specimens of identified flora from the processed samples (n=10). The soil sample from level 3 (20-30 cm.) of XU101 contained one charred nut meat of burr oak (Quercus macrocarpa) and one charred nut hull fragment of hickory (Carya spp.). A number of uncharred plant seeds were also recovered, but they were deposited as part of the area's natural seed rain. The waterscreening also produced small bone elements and fragments, all of which have already been discussed. Since the oak and hickory specimens were found in the occupation zone, they are probably the remains of food items.

The analysis of burned earth, daub, limestone, quartzite, bone, charcoal, and pottery did not find distributional patterns or artifact classes which could be attributed to the presence of a non-Woodland prehistoric component on 14BU57. In fact, the evidence indicated the presence of a Woodland component which exhibits artifact distribution patterns attributable to: (1) disturbance by cultivation, (2) differential preservation, and (3) differential internal use of the site. Except for the projectile point forms already mentioned, artifacts made of chert exhibit the same contextual uniformity (when corrected by allowing for different recovery techniques) and internal distribution patterns. The entire chert sample contains 1,075 items and includes 1,069 pieces of chipped stone, 1 hammerstone, and 5 pieces of fire cracked rock. The contextual uniformity and distribution patterns are best exemplified by those classes of chipped chert that contain numerous members. It can be seen from an examination of Table 4.22 that chunks and shatter, complete flakes, proximal flake fragments, and other flake fragments were found in surface, plowzone, and subplowzone contexts. The difference is that more items were collected from the surface where investigators were not restricted to two meter squares; quantitative differences are a product of the small size of test excavations. Other classes of chipped chert contain too few items to infer contextual or distributional patterns. The total number of chert artifacts found in XU101 (n = 226) relative to XU102 (n = 385) can be accounted for by the differential trash disposal posited earlier for limestone and bone. Thus, except for the projectile point forms to be discussed below, and other serendipitous findings, there will be no need to systematically consider the contextual distribution of chipped stone artifacts.

A spherical cobble of Florence chert was collected from the site's surface. The artifact's surface is completely covered with cortex, except where it was broken, and where it was battered and crushed from use as a hammer. The hammerstone has a diameter of 66 mm. and weighs 242 gm. Before it was broken, it would have been heavy enough to smash bone or limestone, and large enough to be comfortably hand held.

Table 4.22. Chipped stone artifact distribution (14BU57).

Class	Surface Collection	Excavation Units Plowzone XU101	Excavation Units Plowzone XU102	Excavation Units Subplowzone XU101	Excavation Units Subplowzone XU102
Unmodified Raw Materials	1	-	-	-	-
Tested Raw Materials	-	-	-	-	-
Cores and Core Fragments	8	-	-	-	1
Chunks and Shatter	93	33	43	34	59
Complete Flakes	52	8	10	12	31
Proximal Flake Fragments	86	21	18	25	52
Other Flake Fragments	206	30	27	55	119
Resharpening Chips	1	1	-	2	-
Potlids	3	-	6	4	15
Utilized Blanks	-	-	-	-	-
Unifaces	1	-	-	-	-
Bifaces	7	-	-	1	4

Pieces of weathered or rotten chert (5 from the surface and 1 from the plowzone of XU101) were broken and crazed from exposure to heat. Weathered chert may have been used to pave or outline hearths, or as radiant heat sources in roasting pits. Nodules of rotten chert are common in the El Dorado Lake area (e.g., on the beaches of Lake Bluestem, Fig. 1.3).

The lithic assemblage contains only one item of chert large enough to have been made into a core. A large river-rolled cobble of Florence chert is the single artifact in the selected, but untested, raw material class (Table 4.22). This artifact and the chert hammer-stone described in a previous paragraph indicate that the prehistoric flint knapper was obtaining local materials from a river or creek bed. Cobbles of Florence chert can still be procured from the bed of Satchel Creek a few meters upstream of 14BU57.

The sample of cores and core fragments is also small (n=9); eight of these artifacts were recovered from the surface, and one fragment of light gray chert was found in the occupation zone of XU102 (level 3, 30-40 cm.). The data presented in Table 4.23 suggest that

Table 4.23. Cores and core fragments (14BU57).

	Chert Type		
Core Type	Florence	Foraker	Light Gray
Polymorphic	2	-	-
Fragment	4	1	2

only locally available cherts were procured and brought to the site for processing. Florence chert was apparently used more often than the light gray or Foraker. Most of the specimens are fragments, but two artifacts of Florence chert are recognizable as polymorphic cores from which flake blanks were detached. None of the cores or core fragments had been heat treated.

The chunk and shatter data exhibit more variability in chert type and thermal alteration (Table 4.24) than cores. Most of the specimens in this class are large chunks of Florence chert; the two other local chert types, Foraker and light gray, are the next most frequent chert varieties. That these cherts were brought to the site as raw materials for tool production is shown not only by their presence, but also by the high proportions of cortical pieces. Chunks and shatter of light gray chert, however, do not fit the pattern; raw blocks of light gray

Table 4.24. Chunks and shatter (14BU57).

	Cortex		No Cortex	
Chert Type	Heated	Not Heated	Heated	Not Heated
Florence	12	73	26	52
Foraker	8	3	35	14
Light Gray	-	2	12	13
Westerville	2	-	-	-
Miscellaneous	-	2	3	5

chert may have been trimmed or decorticated before transportation to the site, or brought in as already prepared and productive cores. The data indicate that locally available cherts were more often procured for tool production than nonlocal varieties. Florence and Foraker were apparently favored more than light gray. The nonlocal, or exotic, Westerville chert is also represented in the sample; two specimens were collected from the site's surface. The Westerville chunks demonstrate that pieces of exotic chert were procured by some unknown means, brought to the site, and probably technologically modified before being deposited in the archeological record. The Westerville artifacts and many specimens of Florence, Foraker, and light gray exhibit thermally induced color changes. From Table 4.24 it can not be determined if large pieces of these raw materials broke apart under knapping impacts and were then subsequently exposed to heat (as in trash fires, as hearthstones, or as radiant heat sources), or if they were exposed to heat as part of a technological process and then broke apart. The absence of thermally altered cores and core fragments and the high proportion of unheated chunks and shatter suggest that the former alternative is the most likely sequence of events.

The occurrence of a cobble of procured raw material, a few cores and core fragments, and a larger number of chunks and shatter, indicates that chert was obtained by the site's inhabitants and knapped to make tools. The hammerstones, polymorphic cores, and impact debris (core fragments, chunks, shatter) demonstrate that one of the flint knapper's techniques was direct hard-hammer percussion. A study of complete flakes, proximal flake fragments, and other flake fragments supports these inferences and suggests the use of other reduction and manufacturing techniques as well. It should be noted first, that specimens in all three classes were frequent in surface, plowzone, and subplowzone contexts. Generally, the numbers and sizes of complete flakes, proximal fragments, and other fragments are larger in the surface sample than in the excavated samples. These differences are due to the greater area from which surface debris was collected and the greater visibility of large items on the surface. Thus, the size and frequency differences of surface items relative to excavated items is not a product of prehistoric behavior, but an outcome of different recovery techniques.

The complete flakes in the collection vary greatly in size. Most of the cortical Florence flakes are rather large (Table 4.25) and, therefore, indicate the trimming of procured raw Florence nodules to form prepared cores. The same pattern is shown by complete flakes of Foraker and, to a lesser extent, light gray chert. Some of this procured material was probably made into polymorphic flake cores (see above and Table 4.23), but there is also evidence that a different kind of core was prepared. Table 4.25 shows that the sample contains 5 complete blades: 2 of Florence, 1 of Foraker, and 2 of light gray (Fig. 4.19 c,d). Blades are long and narrow flakes which have roughly parallel lateral edges and which have detachment scars on their dorsal surfaces parallel to their long axes. Blades can occasionally be detached from cores that are not specifically prepared or shaped for blade production, but a high frequency of such accidental blades is unlikely. Thus, if it can be shown that the assemblage contains an

Table 4.25. Complete flakes (14BU57).

	Cortex		No Cortex	
Chert Type	Heated	Not Heated	Heated	Not Heated
Florence	1	18[a]	-	31
Foraker	2	6[b]	11	12
Light Gray	1	2[c]	2	15
Winterset	-	1	-	-
Miscellaneous	-	3	2	6

[a]Two blades. [b]One blade. [c]Two blades.

unexpected number of blades, it can be posited that the prehistoric flint knapper prepared blade cores and detached blades from them, even if no blade cores were recovered. This appears to be the situation at 14BU57 where no blade cores were found. The complete flake data (Table 4.25) suggest that blade cores were prepared (presence of complete cortical blades) and that blade blanks were detached; some of the latter broke and were deposited as proximal and other fragments (Tables 4.26 and 4.27). This inference is tentative and not well supported because blade fragments are not always easily distinguished from flake fragments, and the sample of probable blades is small. However, the recovery of 9 possible blades or blade fragments is unexpected in the sense that chipped stone collections from the other four sites tested in 1977 contained no blades or blade fragments. Thus, the former presence of a blade producing technology at 14BU57 is an unconfirmed, but viable hypothesis.

To return to the complete flake data again, most of the noncortical Florence artifacts are medium to small in size; they represent the detachment of blanks from flake cores and the debris resulting from manufacture of tools by retouch. Complete flakes of Foraker and light gray also represent blank detachment and tool retouch debris. Heat treatment of blanks, as a step in tool production sequences, appears to have been applied to Foraker blanks more often than Florence or light gray blanks (Table 4.25). The single complete flake of Winterset chert is a tabular blank; its recovery implies that tabular cores were reduced and it adds another chert type to the list of exotic varieties transported to the site. Striking platform treatments on complete flakes include plain, plain and dorsally reduced, faceted, faceted and dorsally reduced, cortical, and ground. The variability of complete flake sizes and striking platform treatments shows that the prehistoric inhabitants of 14BU57 were knowledgeable flint knappers who used a variety of techniques (including hard-hammer percussion, pressure, and possibly indirect or punch percussion) in conjunction with unprepared and prepared striking platforms to manufacture chipped stone tools.

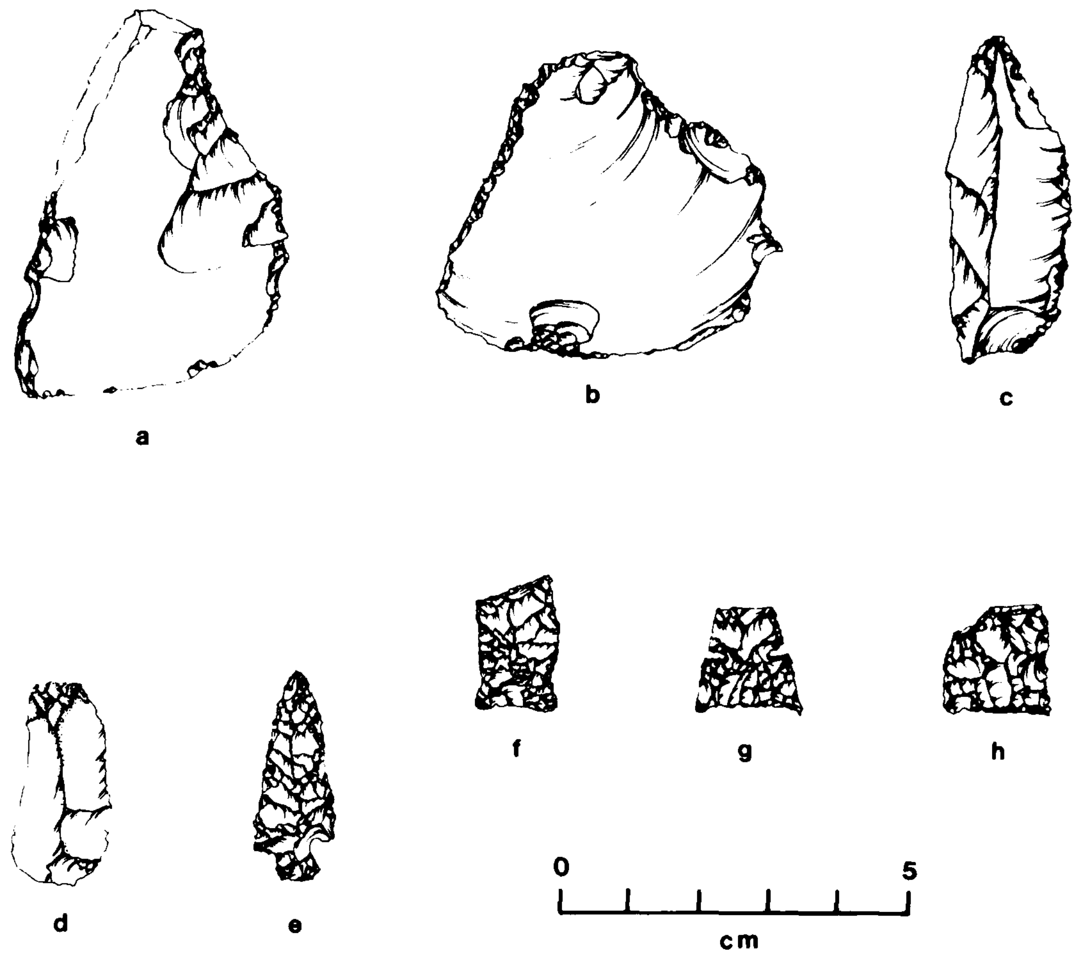


Figure 4.19. Chipped stone artifacts from 14BU57: (a) knife (A5012977-44), (b) side scraper (A5000277-87), (c,d) blades (A5012877-7, A5012877-5), (e) Woodland projectile point (A5012877-5), (e) Woodland projectile point (A5012977-15), (f,g,h) Plains Village points (A5000277-623, A5000277-355, A5000277-354).

The frequencies of proximal flake fragments (Table 4.26) and other flake fragments (Table 4.27) indicate technological patterns similar to those inferred for complete flakes. The local cherts were the most frequent varieties used for tool manufacture, with Florence heading the list, followed by Foraker and light gray in descending order. Exotic raw materials (Alibates and Westerville) are very infrequent, but indicate interregional trade or procurement relationships. Most of the artifacts in the proximal and other flake fragment categories are small and noncortical, suggesting that they are tool production debris. The proportion of thermally altered specimens is high indicating that heat treatment was applied to all three local cherts used for tool manufacture. The counts presented in Tables 4.26 and 4.27 show that noncortical chert blanks were thermally altered more often

Table 4.26. Proximal flake fragments (14BU57).

Chert Type	Cortex Heated	Cortex Not Heated	No Cortex Heated	No Cortex Not Heated
Florence	2	14	7	46[a]
Foraker	1	8	12	42
Light Gray	-	3	9	43[b]
Miscellaneous	1	4	2	8

[a]One blade. [b]Two blades.

Table 4.27. Other flake fragments (14BU57).

Chert Type	Cortex Heated	Cortex Not Heated	No Cortex Heated	No Cortex Not Heated
Florence	3	37	17	94
Foraker	8	17	55	52
Light Gray	1	2	23	88[a]
Alibates	-	-	-	1
Westerville	-	-	-	3
Miscellaneous	1	12	3	20

[a]One blade.

than cortical pieces, and that Foraker blanks were heated most often. Thus, thermal alteration was a technique used to modify noncortical blanks (especially Foraker) for subsequent tool manufacture or use. Thermal pretreatment was an optional, but not a necessary, step in tool manufacture or use; there are many specimens in the two tables that were not thermally modified. Once again, there is the variability in specimen sizes and striking platform treatments (specifically on proximal flake fragments) discussed above for complete flakes. The same inference is drawn, i.e., that prehistoric flint knappers at 14BU57 knew of and used a range of techniques and platform preparations to make stone tools.

The chipped chert assemblage retrieved from 14BU57 contains 4 resharpening chips; 1 was surface collected and 3 were found in XU101 (Table 4.22). The surface collected example is Foraker, noncortical, and not heated; the edge formed by juncture of striking platform and dorsal surface is polished, rounded, and unifacially step faceted. The degradative wear observed on the artifact suggests that it was detached from a scraper to maintain or sharpen a scraping edge. A resharpening chip found in the plowzone of XU101 is also a scraper maintenance flake; it is thermally altered Foraker, partially cortical, and exhibits a rounded and unifacially step faceted former working edge. Two maintenance chips were found in the occupation zone (subplowzone) of XU101. One is light gray, noncortical, and not heated; its former working edge is rounded and unifacially step faceted. The chip's striking platform appears to have been a former retouched surface, so it may have been detached from a biface. However, the degradative wear on the former working edge indicates the tool was used as a scraper. The fourth, and last, resharpening chip is light gray, noncortical, and not heated; the edge formed by juncture of striking platform and dorsal surface is heavily rounded and bifacially step faceted. This pattern of degradative wear is common on knives; the resharpening chip is, in fact, a bifacial knife maintenance flake. The four resharpening chips demonstrate that prehistoric inhabitants at 14BU57 used and resharpened chipped stone tools, probably scrapers and knives.

The presence of potlids demonstrates that chert was exposed to enough heat to produce thermoclastic spalling. Table 4.22 shows that potlids were found in surface, plowzone, and occupation zone contexts, and that a large proportion of these specimens were recovered in XU102. Potlids could have been formed by two different prehistoric activities: (1) the use of chert to pave or outline hearths or as radiant heat sources would have exposed that chert to sufficient heat, and (2) the thermal pretreatment of blanks and/or preforms during the process of tool manufacture may also have exposed those items to sufficient heat. The information presented in Table 4.28 suggests that both activities occurred at 14BU57 and can account for the potlid sample. Eleven

Table 4.28. Distribution of potlid chert types (14BU57).

Chert Type	Surface Collection	XU101	XU102
Florence	1	-	-
Foraker	1	4	4
Light Gray	1	-	6
Indeterminate	-	-	11

specimens found in XU102 are so thermally damaged and crazed that it could not be determined what kind of chert they represent. The 11 potlids indicate that pieces of chert were placed in a thermal environment in which the amount of heat was not controlled with respect to its effect on the chert. The use of chert as hearthstones or radiant heat sources would expose those pieces to sufficient heat in a situation where the occurrence of thermoclastic spalling was of little consequence for the activity performance. It can thus be inferred that pieces of chert were, indeed, used as hearthstones and/or radiant heat sources; this inference was also entertained from a study of chunks and shatter.

Cross-tabulated data were presented for nearly every class of chipped stone artifacts discussed in this section to show that thermal modification was, occasionally, a step in the manufacture of chert tools. It has also been consistently pointed out that among the local chert types, the frequency of heat treatment was highest for Foraker, lower for light gray, and lowest for Florence. This descending order of frequency is also exhibited by potlids for which chert type could be determined (Table 4.28). Furthermore, previous analyses have shown that procured raw materials and productive cores were not thermally altered; this implies that those pieces which were heat treated were blanks, preforms, or, possibly, tools. The amount of heat that blanks, preforms, and/or tools were exposed to during the heat treatment process could have gotten out of control and resulted in thermoclastic spalling, i.e., potlid formation. Thus, the sample of potlids can be accounted for by the occurrence of two prehistoric activities: (1) the use of chert as hearthstones and/or radiant heat sources, and (2) the thermal alteration of blanks, preforms, and/or tools.

Table 4.28 also shows that there were proportionately more potlids in XU102 than in any other context at 14BU57. That this phenomenon is not the result of small sample bias is demonstrated by Table 4.29 where

Table 4.29. Distribution of thermally altered chert (14BU57)[a].

	XU101		XU102	
Chert Type	Heated	Not Heated	Heated	Not Heated
Florence	14	95	34	75
Foraker	25	37	66	52
Light Gray	9	24	22	89
Totals	48	156	122	216

[a]Tabulation does not include potlids or tools.

total counts of heated versus unheated chert artifacts are broken down by excavation unit and tabulated against type of chert (notice that the data do not include potlids, retouched tools, or any surface collected artifacts). More thermally altered chert was recovered in XU102 than in XU101. Recall that XU101 and vicinity were interpreted as an area in which prehistoric trash (limestone and bone meal) produced by cooking was dumped. If pieces of chert were used as hearthstones and/or radiant heat sources, then thermally altered chert would have been dumped in the area as well, along with any chert picked up and disposed of with the trash. XU102 and vicinity did not exhibit a high degree of association between limestone and bone meal; it was interpreted as an area where chert was dumped as trash. The greater proportion of chert in XU102 versus XU101, and the greater proportion of thermally altered chert in XU102 (Table 4.29), suggest that debris resulting from the heat treatment and manufacture of chert tools was disposed of more often in the vicinity of XU102 than XU101. If these inferences are tenable, then additional excavations at 14BU57 should locate food processing (cooking and consumption) areas and chert workshop (tool manufacture and thermal pretreatment) areas.

The descending frequency order of heat alteration inferred for Foraker, light gray, and Florence, respectively, is preserved in XU101, but not in XU102 (Table 4.29). The ranking in XU102 is Foraker (56%), Florence (31%), and light gray (20%). In fact, the lithic assemblage considered as a whole shows that 50% of Foraker chert was thermally altered, and that Florence and light gray are virtually tied at 22% and 21%, respectively. Thus, while all three local varieties of chert were heated, Foraker pieces were altered at a rate of better than 2 to 1 over Florence and light gray. The differential application of heat treatment to varieties of chert poses an interesting and intriguing problem to the lithic analyst; no illuminating hypotheses are readily apparent.

Unfortunately, only a small sample (n=13) of chipped stone tools were retrieved for study. The context of recovery for all tools is summarized in Table 4.22, and their functional identifications are offered in Table 4.30. Notice that there are no utilized blanks in the sample; their underrepresentation, and the underrepresentation of all tool classes, is a result of small sample bias. The single unifacial tool, a side scraper, was collected from the site's surface. The scraper (Fig. 4.19b) is a complete flake of noncortical, unheated, light gray chert; it was made by removing flakes from the ventral surface along the left lateral edge. This unifacially retouched working edge exhibits degradative wear in the form of edge rounding and step faceting, both of which are characteristic scraper wear.

Projectile points comprise the most numerous bifacially retouched tool class (n=6). Five of them were surface collected and all five are fragmentary. One point was made from noncortical, heat treated, light gray chert; it is the basal fragment of a point shaped like an isosceles triangle whose basal and lateral edges were straight. No notches or impact fracture are evident (Fig. 4.19h). The second artifact was made from noncortical, unheated, Foraker chert; it too is a

Table 4.30. Chipped stone tools (14BU57).

	Chert Type			
Tool Class	Florence	Foraker	Light Gray	Miscellaneous
Utilized Blanks	-	-	-	-
Unifaces				
Side Scraper	-	-	1	-
Bifaces				
Projectile Point	-	3	2	1
Chopper	1	-	-	-
Gouge (?)	1	-	-	-
Knife (?)	-	1	-	-
Fragment	1	-	2	-

fragmentary isosceles triangular projectile point. The tip and one basal corner are missing, and it has a semicircular break on one lateral edge. The artifact is complete enough to observe that the lateral edges were straight and that the basal edge was concave. No notches or impact fracture are present. A third projectile point was made from a noncortical, unheated, chert that is probably exotic. The chert exhibits white, tan, and brown parallel bands; no local raw material is known to have a banded structure exhibiting those colors. The point is shaped like an isosceles triangle with straight sides and a concave base. There are u-shaped notches on the lateral edges about 1/3 of the distance from the base, the tip is missing, and in its place is an impact fracture which also removed part of one lateral edge. The fourth specimen is identical to the third except that it was made from noncortical, heated, Foraker chert (Fig. 4.19g). This point also has a missing tip, but there is no impact fracture present. The fifth, and last, surface collected projectile point was made from noncortical, heated, Foraker chert. This artifact differs from the previous points in overall shape; its base is concave, but its lateral edges are restricted (concave) near the base and flare slightly before converging toward the tip (Fig. 4.19f). The basal corners resemble ear-like projections; the tip has been broken off, but there is no impact fracture. This projectile point, when complete, could have been described as a small lanceolate.

The projectile points described above can be viewed as variations on a basic isosceles triangular shape. Variations can occur at the

artifacts' base (straight or concave edge) and at the sides (presence or absence of paired notches, straight or concavo-convex edges). These forms are often associated with temporally late occupations in the locality's culture history sequence; they are specifically taken to indicate "Late Ceramic" or "Plains Village" components (Fulmer 1977; Leaf, chapter 1, this volume). Such points have been dated in the project area (at 14BU71, Fig. 1.3) by radiocarbon assay at 740 $\pm$ 70 B.P. (or A.D. 1210 $\pm$ 70) (Fulmer 1977:79). The five surface collected points from 14BU57 contrast markedly with the projectile point recovered, in situ, from the occupation zone of XU102 (level 3, 30-40 cm.). The latter specimen is complete and made from noncortical, heated, light gray chert. It conforms to the general isosceles triangular shape, except that it has a pair of corner notches (Fig. 4.19e). This particular form is generally attributed to a "Late Woodland" occupation, i.e., a component earlier than Late Ceramic or Plains Village components (Fulmer 1977; Grosser 1970). A Late Woodland site (14BU55) in the project area has been dated by radiocarbon assay at 890 $\pm$ 60 B.P. (or A.D. 1060 $\pm$ 60) and 970 $\pm$ 80 B.P. (or A.D. 980 $\pm$ 80) (Fulmer 1977: 41).

The problem posed at the very beginning of this section should now be evident. Projectile point forms recovered from 14BU57 indicate the presence of two distinct components, yet all other artifact classes and artifact distribution patterns indicate the presence of only one component (disturbed by cultivation). Consider also the following: (1) the late projectile point forms from 14BU71, dated at about A.D. 1210, were associated with chert blades, and with pot sherds tempered with shell, grit (?), or indurated clay and which also had plain or cord marked exterior surfaces; (2) the earlier (Late) Woodland projectile point forms from 14BU55, dated from A.D. 980-1060, were associated with chert blades, and with pot sherds tempered with indurated clay and which had cord marked exterior surfaces; and (3) both projectile point forms were found on 14BU57 along with chert blades, and pot sherds tempered with limestone or indurated clay and which also have cord marked exterior surfaces. This is an admittedly selective comparison of the three sites; there are many other similarities and differences.

The point of all this is that there is apparently a minimum of 150 radiocarbon years separating the occupations at 14BU71 and 14BU55, and that the components on the two sites appear to be different. The results from 14BU57, however, blur the differences; 14BU57 appears to be intermediate in artifact content, especially with respect to the two projectile point forms. There are at least two alternative hypotheses that could account for the problematical cultural historical status of 14BU57: (1) there may actually be two distinct components on the site (one Late Woodland and one Plains Village) that are mixed together in the plowzone; the scale of the 1977 investigations (opportunistic surface collection and two small test pits) was not adequate to document the presence of the Plains Village occupation, or (2) there is only one component on 14BU57 that represents part of the transformation of Late Woodland into Plains Village. The data recovered from 14BU57 support both hypotheses; it can not be decided on the basis of present evidence which alternative is rejectable. However, the problem is interesting and the solution may well be theoretically important for understanding the prehistory of south-central Kansas.

Large bifacially chipped tools include a chopper, a probable gouge, and a probable knife. The chopper was made from cortical, unheated, Florence chert; it is broken. The tool was made by bifacially retouching one side of a large tabular flake to form a sharp edge. The retouched edge is opposite a blunt, cortical surface that would have protected the user's hand during tool use. The chopper was probably broken during manufacture because a break intersects its working edge which does not exhibit degradative wear. The chopper and the probable gouge were collected from the site's surface. The latter artifact was made from cortical, heated, Florence chert. It is rectangular in shape, thick, and is distinctly beveled on one end. All edges are bifacially retouched; they are also battered and rounded as if through heavy use, but so is one entire surface. The specimen has the shape and thickness characteristic of gouges, but the distribution of apparent degradative wear is not consistent with its posited function. Since the tool was surface collected from a barnyard, it was probably heavily damaged by cultivation and/or farm animals. Thus, the identification of the tool as a gouge is uncertain.

The third large bifacial tool was made from a heavily patinated Foraker flake. The flake has a red patina on all surfaces, so was probably a naturally produced spall which was picked up and modified into a tool. One edge was bifacially retouched (Fig. 4.19a) and that edge exhibits rounding from use as a knife. If the knife had been found on the site's surface, it would have been identified as a piece of gravel that was somehow modified by farm animals or machinery. However, it was recovered from the occupation zone in XU102 and, therefore, seems to be a legitimate man-made tool. The use of gravel to manufacture cores or chipped stone tools is not common in the project area, but has been observed on other sites.

The biface fragments listed in Table 4.30 are too small to assign to tool classes; two were recovered in XU102 (level 3, 30-40 cm.) and the third came from XU101 (level 4, 30-40 cm.). Thus, all three artifacts were found in occupation zone levels.

The chipped stone tool collection, considered as a whole, tentatively exhibits two patterns (Table 4.30). Small retouched tools (projectile points) were made from thermally altered Foraker or light gray chert more often than either unheated chert or Florence chert. Large retouched tools were more often made of unheated Florence or light gray chert than Foraker chert. It thus appears that Foraker was preferred for the manufacture of small tools, and that heated Foraker was most preferred for that purpose. Light gray was apparently suitable for the production of both large and small tools, but Florence was preferred only for large tools. The tool assemblage is compatible with such activities as hunting (projectile points, chopper, side scraper, knife) and the working of wood, bone, and plant fibers (chopper, side scraper, knife, gouge).

Site Summary and Discussion

14BU57 is a small site located near the confluence of Satchel Creek with the Walnut River. Surface debris is scattered over an area of about 0.26 ha.; portions of the site have been washed away by the creek and disturbed by cultivation and farm construction. Hand excavated test squares and a series of postholes demonstrated the existence of an intact occupation zone whose lateral extent is isomorphic with the distribution of surface material. The buried occupation zone varies from 20 to 30 cm. in thickness. No evidence for more deeply buried components was found.

Even though no prehistoric features were located, the presence of burned earth, limestone, and bone, fire cracked rock, and charcoal constitute evidence for the former presence of hearths. Likewise, the recovery or daub signals the presence of at least one prehistoric structure, probably a house. Fragments of burned bone, charred seeds, and pottery show that food was prepared and consumed at the site. Subsistence items include bison, deer, medium mammal, small mammal, turtle, acorns, and hickory nuts; possible food items include bird, squirrel, mole, and vole. Faunal and floral remains, wherever they were present, were well preserved. Cord marked pottery sherds were tempered with limestone or indurated clay. River rolled quartzite and chert cobbles were used as pounders or hammerstones.

An analysis of the chipped stone assemblage showed that the prehistoric flint knapper procured and modified three kinds of locally available chert (Florence, Foraker, and light gray) and three kinds of exotic chert (Westerville, Winterset, and Alibates). The nonlocal varieties are evidence for interregional exchange and contacts. A debitage analysis showed that pieces of raw material were prepared and modified into cores. Flake and blade blanks, some of which were thermally pretreated, were retouched and shaped into tools, i.e., projectile points, a scraper, chopper, knife, and a gouge. The small tool sample represents activities such as hunting and the working of wood, bone, and plant fibers.

Several artifact classes exhibited contextual and associational distribution patterns, some of which were not the result of prehistoric human behavior, but which were accounted for by differential preservation processes. Inferences drawn from distribution patterns attributable to prehistoric behavior include: (1) XU101 and vicinity are an area in which trash (limestone and bone meal) produced by cooking was dumped, (2) large mammal long-bones were broken up to extract marrow and grease, (3) XU102 and vicinity are an area in which lithic debris resulting from heat pretreatment and manufacture of chert tools was disposed, and (4) projectile point forms indicate that 14BU57 either contains two temporally distinct components or one component transitional between Late Woodland and Plains Village.

The artifact classes, inferred activities, probable presence of one or more houses, and differential internal site structure suggest that 14BU57 may have been a small semi-permanent village or hamlet.

Furthermore, the presence of an intact occupation zone, the well preserved floral and faunal materials, and the theoretical possibility of a component representing a transition of Late Woodland into Plains Village, all make 14BU57 a significant prehistoric site in the project area. 14BU57 has the potential to increase our understanding of prehistoric subsistence economy, animal butchering practices, food and chert processing technology, intrasite activity structure, settlement location criteria, and culture change. This site exhibits more potential information return than any other site tested in 1977. Therefore, 14BU57 is assigned a high priority status with regard to future salvage excavations at El Dorado Lake.

14BU82

Description

14BU82 is situated on the west side of Walnut River 0.6 km. north of the dam's axis (Fig. 4.2). Discovered and recorded in 1977, this site was tested because it lies within a borrow area from which soils will be taken to build the western end of the dam. The site also lies within El Dorado Lake's multipurpose pool. 14BU82 is located on Walnut River's first terrace above floodplain, but is well away from the river itself. From the approximate center of known surface scatter, the Walnut is 275 m. south and 518 m. east. The northern portion of 14BU82 is in the same cultivated field as 14BU31, yet the two sites are separated by some 500 m.

A contour map was prepared with a transit; the reference point was placed in a fence line that runs through the site. The map (Fig. 4.20) shows little surface relief; the general downhill trend is west and southwest through a stand of trees and brush toward an intermittent southward flowing tributary of the Walnut. This arroyo is 61 m. west of site reference; it was normally dry during work on 14BU82, but runoff flowed through it to the Walnut after heavy rainfall.

As shown in Figure 4.20 the western limits of observable surface debris are unknown. Cultural debris very likely extends west past the treeline because a bison bone was found eroding out of the arroyo's bank. However, the bone was not found with any other artifacts. The arroyo was thoroughly searched and its bank profiled, but no additional evidence for prehistoric occupation could be found. The bank profile was sampled for pollen, with negative results (King, this volume, Chapter 6). The ground surface between the arroyo and the plowed field was covered with heavy underbrush, so no cultural materials could be seen. There is, however, an abandoned farm road along the probable western edge of 14BU82 which crosses the intermittent creek over a gravel covered culvert. Thus, if there were cultural remains west of the present treeline, they were either disturbed by road construction or washed away by erosion; these two observations lead to the conclusion that any further work west of the treeline would probably be unproductive.

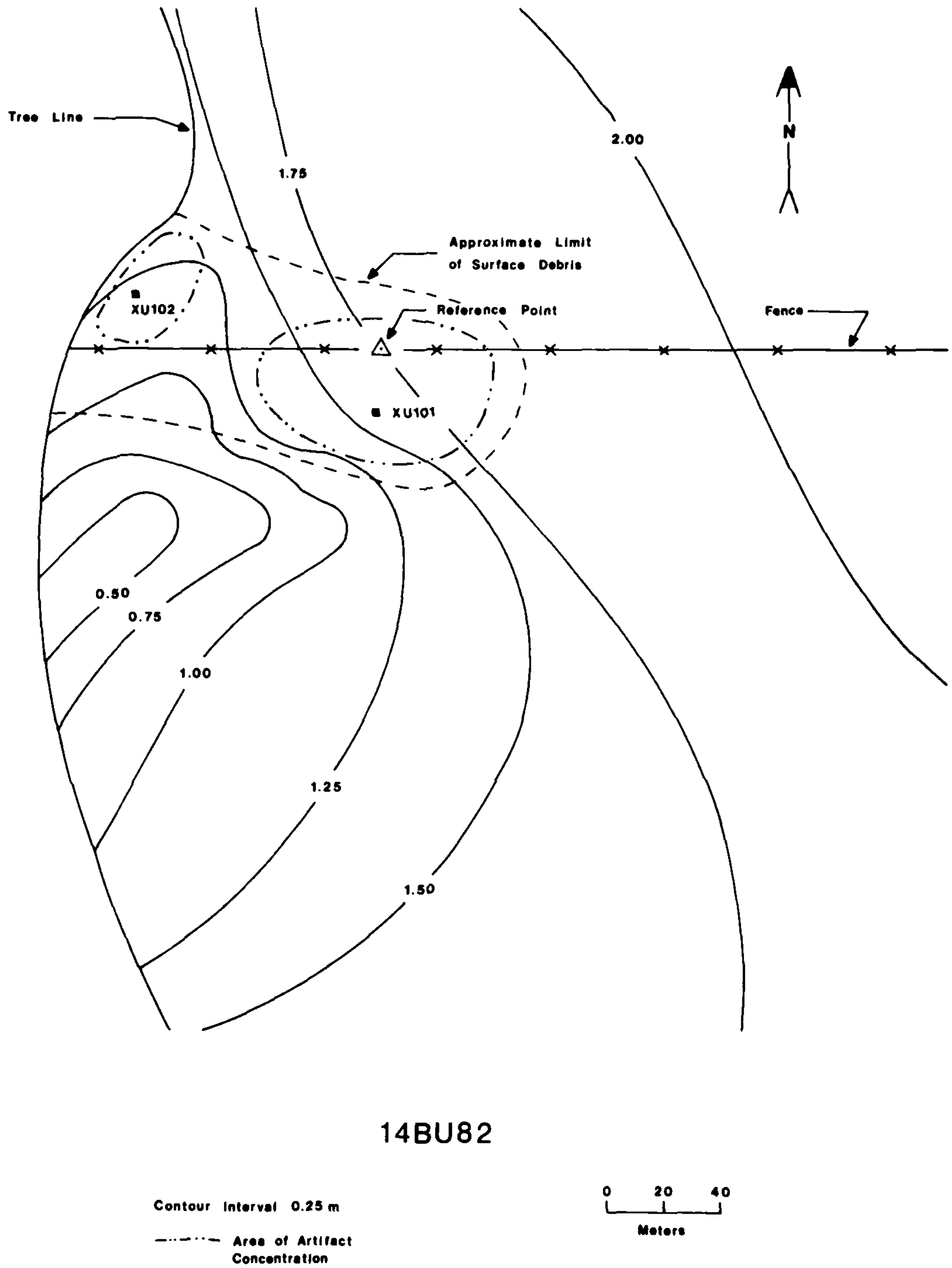


Figure 4.20. Contour map of 14BU82 showing the location of test excavations, limits of surface debris, and internal areas of high artifact concentration.

Since most of 14BU82 was located on recently cultivated land, surface visibility was excellent. The lack of vegetative cover and the frequent rains allowed an easy determination of surface material distribution limits and concentrations. Artifact density was, in general, very low; the observable distribution measured 165 m. east-west and 65 m. north-south. Total surface area is 10,176 sq. m., i.e., slightly over 1.0 hectare. Since the site undoubtedly extended west past the treeline, these figures, especially the east-west and surface area measurements, are low; the amount of error for surface area can be conservatively estimated as 20%. Surface debris was so scarce that a time consuming grid controlled surface collection was not justified. Within the proposed site boundaries, two areas of greater debris density were noted; a test excavation was placed in each (Fig. 4.20). The subarea that contains XU101 circumscribes 3,360 sq. m. (0.33 ha.); it was a concentration of limestone. The second concentration occurred on a slight rise near the treeline where an Archaic projectile point was found along with a quantity of debitage; it covers 864 sq. m. (0.08 ha.).

The site's maximum observable boundaries represent the limits of surface debris. The two subareas represent higher densities of artifacts than were judged average for the rest of 14BU82. These features were not established from an analysis of material collected within a controlled grid system; therefore, the site boundaries and internal concentrations cannot be demonstrated quantitatively. The observations are based, however, on repeated and systematic surface sweeps over the cultivated fields in the immediate vicinity; during those sweeps the debris limits and the concentrations were reaffirmed. The amount of error inherent in placing boundaries around the site and its internal areas in this manner is estimated as ± 10%.

Test Excavations

A two meter grid system was placed on the field map. Site reference was arbitrarily given coordinates 300N200W; hence all possible grid units on the site were in the northwest quadrant. Two 2 by 2 m. squares were laid out, one in each area of high artifact density. In conformance with the site grid system, reference coordinates for each excavation unit identify its southeast corner; all measurements within the excavations were made from the reference corner to the west and north. Elevations were measured with the transit. One test unit (XU101) was placed at 276N200W, the second (XU102) at 318N284W.

Digging was done with the usual hand tools, but to speed up the work only culturally or chronologically diagnostic artifacts and features were plotted in three dimensions. The strategy was to peel off the plowzone plus another centimeter or two to rapidly reach undisturbed deposits, and then to continue down in 10 cm. levels or natural stratigraphic units depending on which was most appropriate. The backdirt was to be screened through a ¼ inch mesh sifter, but once through the plowzone this became impossible because the wet clay

balled up and would not sift. When this situation was encountered, the backdirt was searched a little at a time by hand for artifacts. Troweling through the backdirt is not an adequate recovery technique for finding small specimens, but under the circumstances it was the fastest way to get through large quantities of wet clay.

XU101 was placed in the subarea of concentration that contained limestone; it seemed possible that a hearth or a trash midden may have been disturbed by cultivation. The excavation was started by taking out the first level to a depth of 20 cm. below ground surface; three subsequent levels of 10 cm. depth each resulted in a completed test pit 50 cm. deep. The floor of each finished level was troweled clean and examined for feature stains. Two small circular stains were found on the floor of the first level, but when cross sectioned they were diagnosed as rodent burrows. A large iron machine pin was recovered in one of those burrows. Very few prehistoric artifacts were obtained and most came from the plowzone (Table 4.31). XU101 was

Table 4.31. Depth distribution of artifacts recovered in XU101 (14BU82).

Level	Limestone	Chipped Chert	Burned Earth	Ochre
1	99	40	1	1
2	7	4	-	-
3	-	1	-	-
4	-	-	-	-

essentially devoid of cultural material at 30 cm. below surface (level 2), but two additional 10 cm. levels were taken out to make certain that the test pit had completely penetrated any cultural deposit.

When the west wall of XU101 had been cut back for profile recording, three stratigraphic soil units were observed. At the top was the plowzone, 20 cm. deep, composed of a loose dark brown soil that contained burned wheat stubble and corn stalks. Below the plowzone was stratum 2, a dark brown layer of sediment that extended from 20-38 cm. Stratum 2 exhibited a very high clay content; prehistoric artifacts were present in the uppermost portion of the unit, but were absent in the lower portion. The lowest observed stratum started at 38 cm. below ground surface and extended to an unknown depth. It had a high clay content, was very dark grayish brown in color, and contained no artifacts (Fig. 4.21).

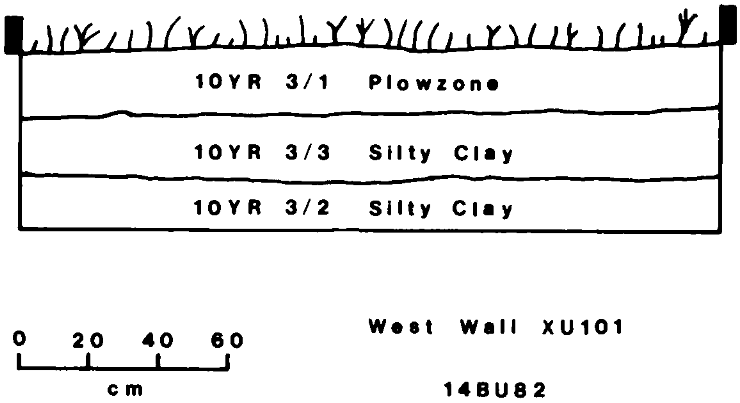


Figure 4.21. West wall profile from XU101 (14BU82).

XU102 was placed in the second internal area of concentration. This subarea was about 30 m. north of where an Archaic projectile point was collected from the surface; it also contained a higher than average surface density of debitage. The test unit was started by taking out the first level to a depth of 25 cm. below surface; four subsequent levels of 10 cm. depth each resulted in a completed excavation 65 cm. deep. The floor of each finished level was scraped clean and inspected for feature stains. No cultural features were found. Even fewer artifacts were recovered in XU102 than in XU101: level 1 yielded 8 pieces of chipped chert and 6 specimens of limestone, level 2 produced only 2 fragments of burned earth. Thus, XU102 contained cultural debris only in the plowzone, below which it was culturally sterile. The soil units in XU102 are identical to those recorded in XU101.

A 17.5 l. (½ bushel) soil sample was taken from each excavation level in XU102 for water flotation and screening. The heavy unfloatable fraction from the upper two levels recovered very little cultural debris: a few chert chips and limestone fragments, a shell fragment, and some burned earth. All five samples, however, contained charred and uncharred wheat stubble. The light fractions recovered no charred floral remains that are unequivocally associated with prehistoric occupations. Floated flora does include charcoal, charred and uncharred plant stems (wheat and corn), and uncharred Chenopodium and Gramineae seeds. Modern crop stalks were recovered from each sample to a depth of 55 cm. (level 4); thus, the flotation samples were contaminated either by plant fragments migrating down through the soil or by being blown into the sample by the wind, or both. Uncharred Gramineae and Chenopodium seeds were found even deeper (level 5, 55-65 cm.); these seeds are common in sampled soils and represent a natural seed rain.

Further rapid testing was accomplished by coring with a hand driven soil probe at 25 m. intervals along the north-south baseline. The purpose of this work was to search for evidence of an intact sub-plowzone cultural deposit with a minimum expenditure of time and effort. No such deposit could be located. The conclusion that may be drawn from the test excavations and vertical distribution of artifacts is that any cultural deposit that once existed on 14BU82 has been disturbed by cultivation, i.e., the site has been churned up by the plow and now exists completely in the plowzone. While the site was being mapped, a phenomenon was observed that may partially explain the heavy disturbance from cultivation. The fence row in which site reference was placed is covered with vegetation; its surface is 25 or more centimeters above the surfaces of adjacent tilled fields. Hence continuous cultivation through the years has allowed rainfall runoff to carry away 25 cm. of loose topsoil. The result is that prehistoric cultural occupations at 14BU82 collapsed together and got mixed in the plowzone. There are no unmixed components or cultural deposits on the site. Additional testing was not conducted with heavy machinery because of the small number of artifacts recovered in excavations, the shallowness of collapsed cultural deposit, and the fact that it was disturbed by cultivation. Given these largely negative results, field investigations at 14BU82 were terminated.

Artifact Analyses

Since most of the artifacts recovered in test pits came from plowzone levels, they were combined with surface collected materials for analysis. Prehistoric items represent five kinds of raw material: (1) ochre, (2) bone, (3) burned earth, (4) limestone, and (5) chert. The single ochre specimen is a very small piece (0.3 gm.) found in level 1 (0-20 cm.) of XU101. It has one surface that was modified by rubbing, probably to obtain red pigment. Six mammal bones were recovered, four of which came from the surface. The four identified elements include a radius, metacarpal, carpal, and ulna from *Bos* (domestic cow); they are not associated with prehistoric occupation. The fifth bone is an unidentified fragment from level 1 (0-25 cm.) of XU102. The last element is the *Bison* metatarsal discovered eroding out of the arroyo cutbank; it may be associated with one of the archeological components on 14BU82.

One piece of burned earth (0.5 gm.) came from level 1 of XU101 and two specimens (total weight 2.3 gm.) came out of level 2 (25-35 cm.) in XU102. All three objects were examined under a microscope for the presence of temper and old sherd surfaces, neither were observed. When the soil profiles on 14BU31 were discussed, it was noted that noncultural sediment strata may contain charcoal and burned earth. Burned earth can therefore have both natural and cultural origins. The specimens from 14BU82 have questionable associations and contexts vis-a-vis other artifact classes, but the presence of burned limestone on the site indicates the cultural control of fire. The most likely source of burned earth and burned limestone is from hearths. No hearths, however, were observed in the excavations, but they would have

been disturbed beyond recognition by a combination of plowing and topsoil erosion.

Limestone is the second most frequent raw material class. Only 1 of the 191 specimens show any modification other than having been brought to the site and exposed to heat. The artifact has one slightly concave surface that is smooth and regular; its maximum length is 5.9 cm. and it weighs 49 gm. The modified piece may be a metate fragment. Other limestone chunks range in size from less than 1 gm. to more than 500 gm. Table 4.32 compares the frequencies and weights of specimens

Table 4.32. Limestone counts, weights, and distribution (14BU82).

	Number	Weight (gm.)
Excavated		
Burned	14	57
Not Burned	98	175
Surface Collected		
Burned	35	2,010
Not Burned	43	2,793
Site Totals		
Burned	49	2,067
Not Burned	141	2,968

from excavations and surface collection. The smaller number and greater total weight of burned and unburned limestone in the surface collection illustrate a clear bias in favor of large pieces. Recall that not all of the surface limestone was picked up; most of it was left on the site. Thus, it is difficult to assess the significance of the relatively smaller proportions of burned versus unburned limestone. Furthermore, the soft and heat discolored surfaces of burned limestone may have been eroded away. Even though there is little corroborative evidence to support the interpretation, most of the limestone brought to 14BU82 was probably used as hearthstones, i.e., to pave or outline fire pits. Limestone is, of course, ubiquitous in the Kansas Flint Hills; there is an outcrop 300 m. west of the site.

By far the greatest amount of information about prehistoric social behavior at 14BU82 was obtained from a study of chipped stone artifacts. An inspection of Table 4.33 shows that 89% of the lithic assemblage

Table 4.33. Chipped stone artifact distribution (14BU82).

Class	Surface Collected	Excavated
Unmodified Raw Materials	3	-
Tested Raw Materials	3	-
Cores and Core Fragments	22	-
Chunks and Shatter	63	10
Complete Flakes	27	3
Proximal Flake Fragments	84	9
Other Flake Fragments	174	27
Resharpening Chips	2	-
Potlids	6	1
Utilized Blanks	-	-
Bifaces	13	-
Unifaces	7	1

came from the site's surface and 11% from test excavations. It can be further noted that all but one of the technological classes of interest contain artifact members. As will be discussed in greater detail below, there are different prehistoric components mixed together in the surface/plowzone collection. Except for culturally and chronologically diagnostic projectile point forms, no artifact can be assigned with any degree of confidence to the occupations which deposited them.

Six blocks of locally available chert large enough to have been modified into cores or core tools were procured and brought to 14BU82 (Table 4.34); all six artifacts have cortical surfaces. The three tested blocks have one fresh flake scar; thus, the prehistoric flint knapper "tested" the quality of each piece before bringing it to the site. Florence and Foraker are not the only chert types found in the lithic collection, but they may be the only kinds of chert selected and transported to the site in their naturally occuring form.

Table 4.34. Selected raw materials (14BU82).

Chert Type	Unmodified	Tested
Florence	2	2
Foraker	1	1

The presence of cores indicates one or more of several possible lithic technological activities: (1) procured raw material may have been transformed into cores or core tools, (2) blanks for utilization or tool production may have been struck from cores, and/or (3) cores may have been cached, lost, or exhausted and discarded. The decortication flakes and other large flakes in the collection suggest that procured raw materials were trimmed and made into cores, and that blanks were struck from those cores on the site (see discussion of debitage below). This interpretation is also supported by the presence of chunks, shatter, core fragments, and a number of rather large flake fragments. Four kinds of core were recovered (Table 4.35); the nine

Table 4.35. Cores and core fragments (14BU82).

		Chert Type	
Core Type	Florence	Foraker	Light Gray
Polymorphic	3	1	1
Discoidal	1	1	-
Single Ended	1	-	-
Double Ended	-	-	1
Fragment	6	-	7

specimens are different varieties of flake core, i.e., detachment scars on cleavage faces demonstrate that flake blanks were removed. Note that one discoidal and one polymorphic core are made from Flint Hills light gray chert; this type of chert is also represented by chunks, shatter, trim flakes, and flake fragments. Blocks of light gray chert may have been brought to 14BU82 as selected raw material and transformed into flake cores, even though no artifacts representing this inferred prior state were retrieved.

The discoidal core made from light gray chert exhibits scars on one remnant cleavage surface that probably resulted from detaching blades. This inferred blade technique is very tenuous because the artifact collection contains no blade cores or blades. An examination of core striking platforms revealed that the prehistoric occupants of 14BU82 prepared striking platforms prior to blank detachment in several different ways. Preparation methods include nodule quartering to produce a plain striking platform, multiple faceting, and dorsal reduction. A single ended flake core made from Florence chert exhibits a nodular precore form; it was quartered in order to prepare a striking platform. Several cores have striking platforms that were not prepared: they are either cortical or patinated. Dorsal reduction occurs with plain and patinated core platforms.

As far as could be determined, precore raw material forms include heavily patinated (brown) gravel and cortical nodules in addition to the blocky form referred to above. Thus, chert was being obtained from stream beds, limestone outcrops, and talus deposits. The use of gravel as a source of chippable stone poses a problem for the lithic analyst. Since the alluvial sediments in and on which prehistoric sites are often found contain naturally deposited gravel, it is sometimes not easy to determine if a specific piece of gravel is culturally modified or not, particularly if the specimen was recovered from the surface or in the plowzone. The chert artifacts described above are definitely chipped stone cores; remnant surfaces which are rounded and patinated demonstrate that they were made from gravel. Pieces of gravel collected from the Walnut River have rounded surfaces covered with a red or brown patina. The red patina is, of course, quite different from the reddish or pinkish colors induced by thermal alteration. In this regard it is important to mention that not one core shows a color change from heat treatment. However, 3 of the 13 core fragments (Table 4.35) have such color changes; exhausted or badly broken cores may thus have been recycled and used as hearthstones, boiling stones, or radiant heat sources.

Chunks and shatter demonstrate that relatively heavy hard-hammer percussion was one chipping technique which occurred on the site (Table 4.36). That most specimens have cortical surfaces and are not

Table 4.36. Chunks and shatter (14BU82).

	Cortex		No Cortex	
Chert Type	Heated	Not Heated	Heated	Not Heated
Florence	1	39	6	6
Foraker	1	3	6	1
Light Gray	-		5	2
Miscellaneous	2	1	-	-

thermally altered suggests that many resulted from the collapse of selected raw materials and cores upon heavy initial impacts. Since blocks, nodules, and cores were not heat treated, the thermally altered elements in the class imply that heavy percussion was not the only mechanism that produced chunks and shatter. Two chunks were exposed to so much heat that they sustained thermal damage in the form of potlid scars and crazed fracture patterns. In the absence of contextual and associational data, it is impossible to determine if such specimens resulted from thermoclastic spalling of larger pieces or if they were chunks first and then got heated. The most probable sequence of events cannot be inferred by examining the artifacts directly, but both alternatives are possible. As was the case inferred for core fragments, chunks and shatter could have been used as hearthstones or boiling stones. Thermally induced color changes could also have resulted from accidental or intentional discard into a burning hearth or trash fire.

Complete flakes and proximal flake fragments imply that blanks were struck from cores and that tools were manufactured at the site. Most of the large complete flakes have cortical dorsal surfaces. Thus, raw materials were brought to the site and trimmed into cores; this interpretation fits well with the inferences already derived from the analysis of cores and selected raw materials. It can be seen from Tables 4.37 and 4.38 that the most commonly used cherts are Florence, Foraker, and light gray. The data also indicate that cortical specimens, i.e., core preparation and trimming debris, are generally not thermally altered. A complete flake of Westerville chert is of special interest; it is a large flake that was detached from a polymorphic flake core. One of the proximal flake fragments of Westerville chert has a completely patinated dorsal surface. From these two specimens it may be posited that Westerville chert was brought into the El Dorado Lake locality as selected raw materials or as cores, or both, since Westerville is not a local raw material. Striking platform treatments observed on complete flakes and proximal flake fragments include multiple facets, facets and dorsal reduction, plain, unprepared

Table 4.37. Complete flakes (14BU82).

	Cortex		No Cortex	
Chert Type	Heated	Not Heated	Heated	Not Heated
Florence	-	3	-	4
Foraker	2	12	-	2
Light Gray	-	1	-	2
Westerville	-	-	1	2
Miscellaneous	-	-	-	1

Table 4.38. Proximal flake fragments (14BU82).

Chert Type	Cortex: Heated	Cortex: Not Heated	No Cortex: Heated	No Cortex: Not Heated
Florence	-	5	5	16
Foraker	4	11	16	16
Light Gray	-	-	5	8
Westerville	-	1	-	1
Miscellaneous	1	1	-	2

cortical, plain and dorsal reduction, and unprepared patinated. These methods of striking platform treatment are identical to those observed on the cores.

When the tabulations for other flake fragments (Table 4.39) are examined in conjunction with those for complete flakes and proximal fragments, it is evident that the proportion of heat altered and/or noncortical specimens increases. This observation appears to be a size dependent factor in that large cortical specimens were not often heated whereas small pieces of debitage, regardless of whether they are cortical or not, were more likely to have been thermally altered. The pattern indicates that some blanks were heat treated as a preparatory step in tool production. Furthermore, most of the heat altered debitage is small and is probably a product of tool manufacture, i.e.,

Table 4.39. Other flake fragments (14BU82).

Chert Type	Cortex: Heated	Cortex: Not Heated	No Cortex: Heated	No Cortex: Not Heated
Florence	7	20	10	35
Foraker	14	25	27	25
Light Gray	3	2	7	19
Westerville	1	-	3	-
Miscellaneous	-	1	1	1

the edges and/or surfaces of thermally altered blanks were shaped via retouch. The presence of small but heated and cortical pieces of debitage show that suitable trim flakes were also shaped into tools.

Thermal alteration per se was a procedure applied to all chert types found on 14BU82. The cross tabulations (Tables 4.37, 4.38, 4.39) demonstrate that heat treatment was not a necessary or required step in tool production technology since not all recovered tools and debitage exhibit color changes. The data do show, however, that Foraker chert was thermally altered more often than other types of chert. Seven potlids were recovered from the site; five are of Foraker chert and two are of light gray chert. Their presence demonstrates that chert was exposed to heat at the site; they may be a product of the heat pretreatment of blanks or the use of waste chert for hearthstones, boiling stones, or radiant heat sources.

There are 11 retouched artifacts complete enough to describe as tools (Table 4.40). Note the absence of utilized blanks in the tool sample (Table 4.33). Unifaces include 4 side scrapers, 1 end scraper and 1 notch. The notch or concave scraper (Fig. 4.22c) is on the lateral edge of a Foraker flake fragment. Unifacial retouch in the concavity is very steep; flakes were driven from the piece's ventral surface. The working edge is rounded and step faceted, both of which are characteristic scraper wear. The end scraper was made on a core fragment; the tool's ventral surface has large flake scars and the

Table 4.40. Chipped stone tools (14BU82).

	Unifaces			
Chert Type	Side Scraper	End Scraper	Notch	Fragment
Florence	1	-	-	-
Foraker	2	-	1	1
Westerville	1	-	-	-
Winterset	-	1	-	-
	Bifaces			
Chert Type	Projectile Point	Axe	Knife	Fragment
Florence	-	1	-	-
Foraker	2	-	-	2
Light Gray	1	-	1	6

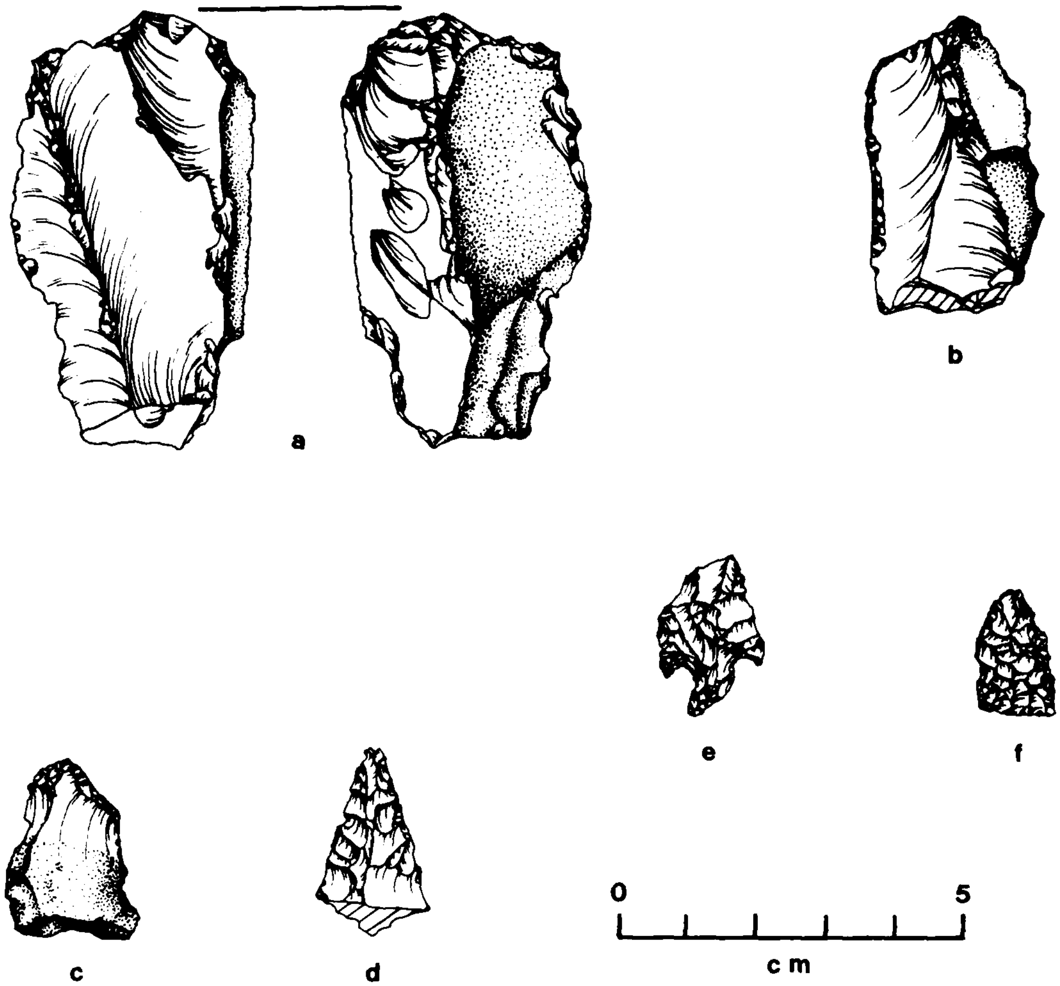


Figure 4.22. Chipped stone tools (14BU82): (a) end scraper made on core fragment (A5002177-183), (b) side scraper (A5000977-193), (c) notch (A5002177-199), (d) projectile point tip (A5002177-180), (e,f) arrow points (A5002177-181, A5000977-182).

dorsal surface is covered with cortex. The artifact is classified as an end scraper (Fig. 4.22a) because there is steep unifacial retouch at one end of the long axis. Retouch flakes were driven off the dorsal surface. The end scraper is made of Winterset chert (also found in the Kansas City group stratigraphically below Westerville (Reid 1978)) and, therefore, represents a nonlocal raw material. The retouched end was probably convex in shape before it was damaged by farm machinery. The working edge is rounded and step faceted.

Side scrapers vary in size from the largest specimen made of Florence chert, to two medium sized pieces made of Westerville and Foraker chert respectively, to the smallest specimen made of Foraker chert (Fig. 4.22b). The Foraker and Westerville tools have color

changes from heat treatment; the Florence tool does not. What all of the scrapers have in common is that they were made by unifacial retouch along the lateral edge of a flake blank. The medium and small artifacts have straight working edges where retouch flakes were driven from the blanks' dorsal surface. The large side scraper has a gently curved convex working edge where retouch flakes were driven from the blank's ventral surface. All four tools have typical scraper wear on their working edges, i.e., the edge is rounded and step faceted. Two uniface fragments (Table 4.40) were thermally altered, but are too small to determine what kind of broken tool they represent. Both pieces have unworn retouched edges so they may be fragments of chipped stone tools which broke while being manufactured. One uniface fragment was recovered in an excavation; it was found in the plowzone of XU101. All other stone tools were collected on the site's surface.

The biface sample provides some idea of how many components may once have been deposited on 14BU82 (Table 4.40). Two bifaces made of light gray chert are long, slender, leaf-shaped lanceolate forms (Fig. 4.23b, c). Neither artifact was thermally altered, but both have surfaces completely scarred by retouch flake detachments. Both ends of the tool illustrated in Figure 4.23b are broken; the lower end has ground lateral edges. The artifact is similar in shape and size to lanceolate projectile points known to occur on Plains Archaic sites and can be reasonably identified as an Archaic dart point. The other long and narrow biface (Fig. 4.23c) has less regular retouch along its serrated and steeply beveled sides, is asymmetric in outline, and has rounded ends which are not broken. The wider end of this artifact was not ground or dulled, but both lateral edges and the narrow end are rounded and step faceted. The artifact is probably a knife that has been used and resharpened.

Two small projectile points indicate that there is at least one other distinct component on 14BU82; neither are associated with a Plains Archaic cultural affilation. A small corner notched point has a partially broken stem, an impact fracture on its distal end, and is made of heat treated Foraker chert (Fig. 4.22e). This projectile point style is common on Woodland sites and indicates that there was a Woodland occupation on the site. The other small point (Fig. 4.22f) has an isosceles triangular shape, is unnotched, made of heat treated Foraker chert, and has fairly straight sides and base. The tip or pointed end has been slightly damaged. This point form is most commonly found on Plains Village sites. The projectile points recovered at 14BU82, therefore, suggest that the site may contain Archaic, Woodland, and Plains Village materials.

The last complete biface is much thicker and wider than the points described above. The artifact is made of heat treated Florence chert. Its outline is quite asymmetric; the lateral edges are irregular and converge to two rounded ends. The larger end has a crushed, rounded, and step faceted edge; the smaller end has no degradative edge wear. A large concavity on one lower side (Fig. 4.23a) was intentionally knapped and is interpreted as a modification produced for a haft or handle. The tool has the shape and wear patterns expected of a chipped stone axe.

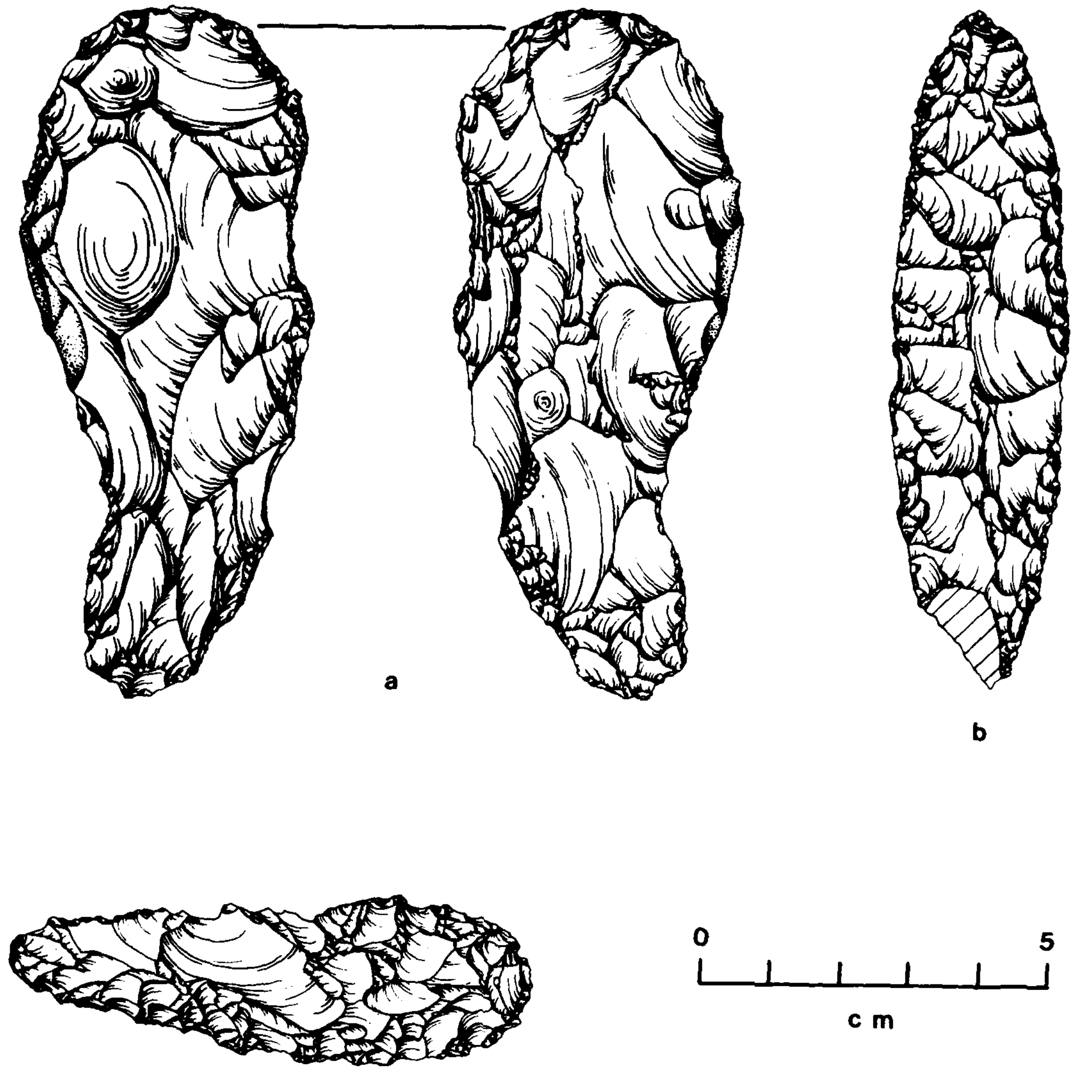


Figure 4.23. Large bifaces from 14BU82: (a) axe (A5002177-160), (b) lanceolate projectile point (A5000977-178), (c) knife (A5000977-179).

The remaining bifacially chipped artifacts are fragmentary. Three thick pieces are of unheated light gray chert and appear to be parts of rather large tools. Two somewhat thinner pieces are made of Foraker chert, one of which was heated; they may be fragments of knives or projectile points. The last three fragments are made of unheated light gray chert; all three are pointed and may be distal end fragments of knives or projectile points. One of them is definitely a projectile point tip; it is pointed and has an impact fracture (Fig. 4.22d). The fragment probably came from a projectile point similar to the Archaic dart point discussed above.

The maintenance of chipped stone tools is documented in the form of two resharpening chips (Table 4.33). Neither of the flakes exhibit cortex, heat alteration, lateral edge wear, or retouch, but both have heavy degradative wear on the edges formed by juncture of striking platform and dorsal surface. The use wear consists of edge rounding, polish, and step facets. Both specimens may have been detached from a large end scraper (similar to the one illustrated in Figure 4.22a) in order to obtain a fresh working edge. Also note that 50% (6 of 12) of the complete tools described above had been heat treated. This proportion is consistent with the inference made earlier that blanks, not cores, were thermally altered in preparation for tool manufacture. Thus, lithic debris that exhibits heat induced color changes includes some retouched tools and some debitage produced by tool production and maintenance.

Site Summary and Discussion

14BU82 is a relatively small archeological site whose surface debris is thinly scattered in a 1.0 hectare area on the Walnut River's first terrace. Its prehistoric components are mixed together and occur exclusviely in the plowzone; there are no intact cultural deposits. Projectile points collected from the surface indicate the probable presence of three occupations: Archaic, Woodland, and Plains Village. Water flotation and screening of soil samples from one test excavation produced no faunal or floral remains associated with prehistoric occupancy of the site. A Bison metapodial was found in an arroyo cutbank immediately west of 14BU82, but its prehistoric context is uncertain.

Virtually all inferences about cultural activities are derived from analysis of surface collected artifacts. The presence of burned limestone, thermally altered chert and potlids, and burned earth indicate the former presence of hearths and the control of fire. The recovery of selected and tested raw materials, cores, trim flakes, chunks and shatter, small debitage, and resharpening chips demonstrates that the prehistoric flint knapper collected suitable stone, transported those materials to the site, made cores, detached blanks, manufactured tools, and maintained worn tools. Some chert was thermally altered as part of the tool manufacturing technology. The kinds of chert most commonly used are three local varieties: Florence, Foraker, and light gray. Westerville and Winterset chert were also recovered from 14BU82; these nonlocal chert types are evidence for interregional exchange.

Six kinds of chipped stone tools were collected: 4 side scrapers, 1 end scraper, 1 notch (or concave scraper), 3 projectile points, 1 axe, and 1 knife. A small piece of limestone may be a metate fragment. All of these utensils can be functionally interpreted as components of hunting-gathering tool kits. The thinly scattered artifactual debris present on the surface and in the plowzone indicate that occupation was very light and probably quite temporary. This inference in conjunction with the evidence for hearths, tool manufac-

ture, and the tool classes mentioned above (all of which were deposited by three culturally and chronologically distinct occupations) suggest that 14BU82 was a transitorily used hunting-gathering campsite.

However, since all of the artifact classes are irrevocably mixed together by cultivation, they cannot be reliably interrelated nor can it be determined which occupation deposited them. There is one valuable conclusion that may be drawn from the investigation, i.e., there may be other very small and very thin sites at El Dorado deposited by Archaic, Woodland, or Plains Village peoples which represent functionally specific loci in the respective settlement systems. It should not be automatically assumed that such "unproductive" small sites are insignificant sources of subsistence and settlement system data.

The results from field investigations and artifact analyses demonstrate that future work on 14BU82 is not warranted.

14BU30

Description

The fourth site tested in 1977, 14BU30, is located on the west side of Walnut River 1.6 km. north of the dam's axis. The site lies on the surface of the Walnut's first terrace across from the mouth of Satchel Creek; it is one of three sites that are clustered around the confluence of Satchel with the Walnut (Fig. 4.2). 14BU30 will be inundated by El Dorado Lake's multipurpose pool, and it is in the west borrow area. This site was first recorded in 1967 at which time a light surface scatter of chert and burned limestone was observed. No culturally or chronologically diagnostic artifacts were found (Eoff and Johnson 1968). 14BU30 was not investigated again until the present study.

Work started in September after several months of intermittent rainfall. The testing crew had visited the area on numerous occasions and, in spite of the mud, was able to determine that surface material was scarce and limited to one large plowed field. Debris was not distributed evenly or continuously on the surface; it occurred in several discrete areas of concentration. By the time test excavations were begun, the field had been fertilized to encourage the growth of vegetation for grazing cattle. Thus, the new and rather vigorous weed patch made it impossible to determine site boundaries accurately or to isolate and count the internal loci where artifacts were thought to be more concentrated.

14BU30 was mapped with transit and metric leveling rod; site reference (arbitrarily designated as 100N100W) was placed on a slight rise near the southern end of the cultivated field. The area covered by the map (Fig. 4.24) contains most of the site. However, surface

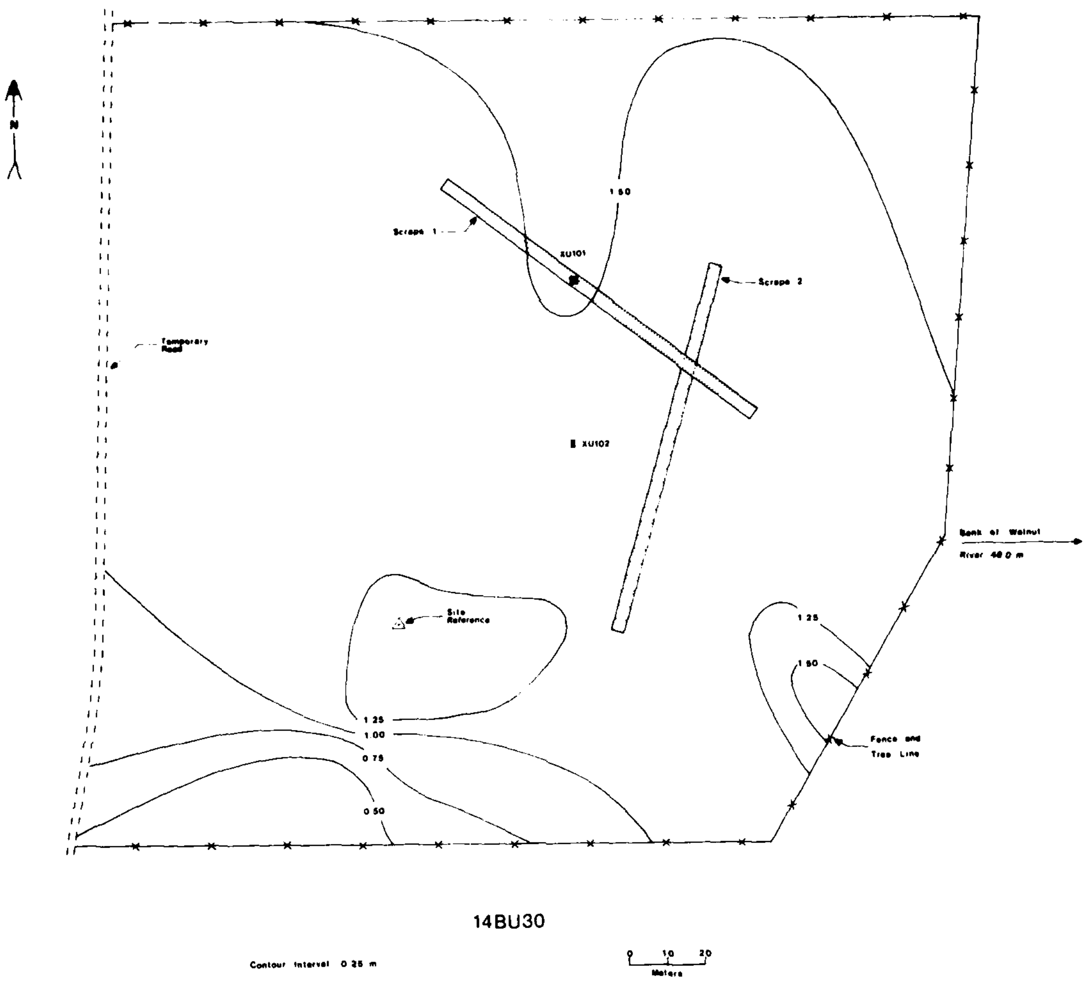


Figure 4.24. Contour map of 14BU30 showing the location of test excavations and earth mover scrapes.

material was picked up a few meters north of the northern fence and a few meters west of the temporary farm road. No debris boundaries or concentrations are illustrated because of the uncertainty of their locations. If the field is ever cultivated again, it will be desirable to return to the site and obtain that information. The area shown in Figure 4.24 covers 47,600 sq. m. (4.76 ha.). This areal estimate is not accurate. If the surface concentrations could be mapped and counted, the total surface area measurement would be much smaller. 14BU30 may actually be a series of very small sites that just happen to be near each other, rather than one large site with internally distinguishable loci. This is another problem that may be addressed in future field seasons.

The surface of 14BU30 exhibits about 1.0 m. of relief, generally going uphill from north to south. There is a slight ridge south of the transit station that may be a natural levee remnant. The treeline on the east marks the edge of a terrace which then drops about 1.5 m. to

the surface of present floodplain. Walnut River is 46.0 m. east of the first terrace's edge; it flows 6.0 m. below floodplain surface and 7.5 m. below the surface of 14BU30. The site is situated on the same terrace surface as 14BU31; the latter site is 400 m. southeast. Land surface west of 14BU30 stays nearly level until the valley edge is reached at a distance of some 700 m.

Test Excavations

It has already been mentioned that when investigations at 14BU30 were started, its surface was covered with a lush growth of vegetation. Also, previous surface collection sweeps had been disappointing in terms of artifact counts, boundary delimiting, and detection of debris concentrations. Extant conditions did not justify the implementation of a grid controlled surface collection. Given the lack of precise information on site boundaries and internal surface distribution, the placement of test pits without more data was, at best, a blind venture. In order to increase the chance of laying out test excavations in areas of heavier artifact concentrations, a large earth mover was used to scrape away part of the plowzone (Fig. 4.25). The swaths were laid out with hubs and string (for operator guidance) in the eastern half of the site where surface debris was known to be more common. The scrape paths intersected, but were not aligned with the site's two meter grid system; the machinery had to have plenty of room to maneuver (Fig. 4.24). The two swaths are each 3.5 m. wide and 100 m. in length. Several passes through each scraped area resulted in the removal of from 12 to 25 cm. of topsoil; since the plowzone is 20 cm. deep, the machine removed subplowzone sediments in some places.

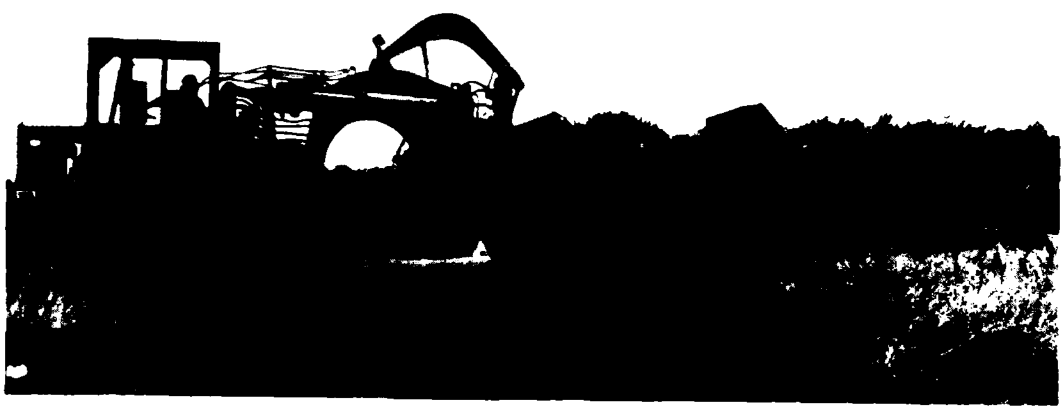


Figure 4.25. Earth mover cutting scrape number 2 (14BU30).

Eleven artifacts were found and plotted in scrape 1, but only 6 were uncovered in scrape 2. In general, the distribution of these artifacts resembled the thin scatter found on the site's surface, except for one small concentration of pot sherds, burned earth, and chert debitage in the first scrape. A 2 by 2 m. square, XU101 (187N53W), was placed over the concentration and aligned with the grid system. The earth mover left a flat but sloping floor in this part of the swath, so the rest of the plowzone was removed to level the excavation relative to original ground surface (Fig. 4.26). The plowzone extended to 20 cm. below ground surface; it was very dark gray in color, loose and unstructured, and contained charred and uncharred wheat stubble as well as a modern, but rusty, fence staple. Three 10 cm. levels were dug below the plowzone through a very dark grayish brown silty clay. This digging was done with hand tools, backdirt was screened through a ¼ inch mesh sifter, and level floors were cleaned and inspected for feature stains. No features were detected. Including material from the scraped and/or hand excavated plowzone, XU101 yielded a total of 23 prehistoric artifacts, seven of which came from subplowzone levels. Flecks of burned earth were present in the plowzone, but not in deeper levels. The excavation was dug to a total depth of 50 cm.

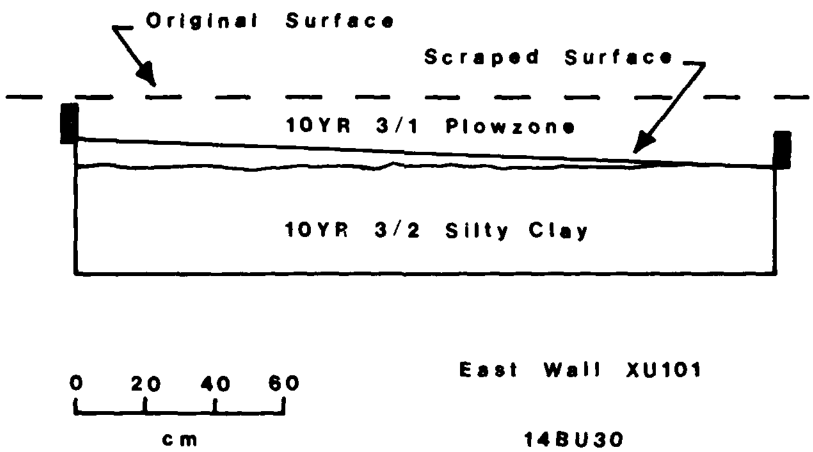


Figure 4.26. East wall profile from XU101 (14BU30).

The data obtained from surface collections, earth mover scrapes, and excavated levels in XU101 indicated that 14BU30 was probably a widely scattered and very thin site contained in the plowzone. XU102, a 1 by 2 m. trench (146N53W), was placed in an area that had not been scraped by machinery. This test pit was dug by hand to a depth of 51 cm. The plowzone was 21 cm. deep; it was followed by three levels of 10 cm. each. Thirty-one pieces of chert debitage and one small pot sherd were recovered from the plowzone; no artifacts whatsoever came from lower levels. No feature stains were observed. XU102 confirmed the suspicion that 14BU30 had been completely disturbed by cultivation. A posthole was drilled down another meter in depth through the floor

of XU102; there is no evidence for the presence of any buried cultural deposits. Soil samples for water flotation and screening were taken from each level of XU102, but in view of results from the test pit they were not processed. The soil profile in XU102 was identical to that recorded in XU101 (see Fig. 4.26).

The conclusions that may be reached from field work at 14BU30 are evident. Whatever cultural deposit may once have existed has been destroyed by plowing. Prehistoric artifacts were found almost exclusively in the plowzone. There are no intact prehistoric components left on the site. Furthermore, surface debris is so scarce that a determination of site boundaries and internal artifact distributions could not be reliably made.

Artifact Analyses

All prehistoric artifacts retrieved from 14BU30 are treated as a surface collection. Five raw material classes are represented in the site's assemblage: (1) burned earth, (2) limestone, (3) sandstone, (4) ceramics, and (5) chert. A single piece of burned earth which weighs 2.6 gm. came from the plowzone in machine scrape 1. The specimen was examined under a microscope for temper, sherd surfaces, and wattle or grass impressions, but none of them were observed. Flecks of burned earth were noted in the excavations throughout the site's plowzone; these numerous small pieces could have been produced when wheat stubble was burned. The large piece of fired earth is probably prehistoric in origin; it may have come from a hearth that was destroyed by cultivation. Additional evidence for the former presence of hearths is the limestone sampled from the site's surface. Twenty-one pieces were picked up; about half show thermally induced color changes (Table 4.41). The relative numbers and total weights of burned versus un-unburned limestone are not meaningful because specimens were picked up at convenience. The sample is not representative, but it does indicate that limestone was brought to the site and that some of it was exposed to heat. Thus, limestone may have been used to pave hearths or radiate stored heat in roasting pits.

Table 4.41. Limestone counts and weights (14BU30).

	Number	Weight (gm.)
Burned	13	802
Not Burned	8	139

Sandstone is represented by a shaped mano or grinding stone. The artifact is made of a hard, fine grained sandstone which has a light brown color on freshly broken surfaces and is dark brown on older

surfaces. The mano was probably imported or manufactured from nonlocal material. The artifact has one end broken off and has numerous scratches and gouges on its surfaces from being hit by farm machinery; in fact, its present state nicely illustrates what happens to artifacts that are constantly shifted around by cultivation (Fig. 4.27). The mano was shaped by pecking and grinding into a rectangle with rounded corners. Its sides and upper surface are roughly shaped, whereas the illustrated working surface has been worn to a smooth, slightly convex surface which joins the tool's sides at sharp angles. In end view the mano exhibits a single bevel, i.e., one long side is thicker than the other; the implement thus had one major grinding direction and was not uniformly worked back and forth nor was it rotated. The mano weighs 556 gm.; it is 7.8 cm. long and 11.6 cm. wide. It is large enough to have been powered with two hands. The recovery of a mano implies that plant foods, such as seeds or nuts, were ground in preparation for consumption. This also implies that human skeletons, should they be found on sites in this time period, will probably have badly worn teeth from the gritty diet. The mano, of course, was probably used with a metate, but none of the latter were found.

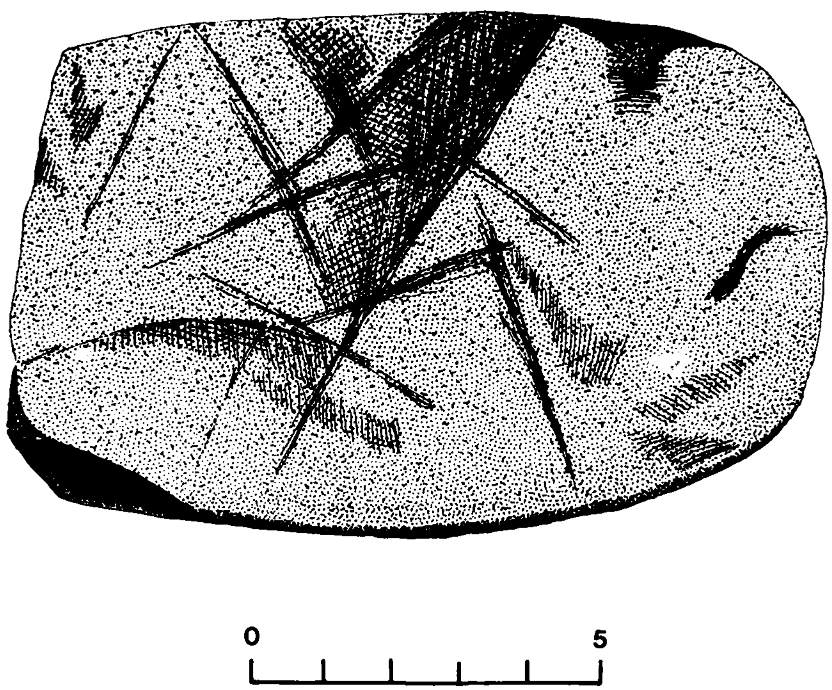


Figure 4.27. Sandstone mano, 14BU30 (A5000477-9).

A very small sample of pottery was obtained. From a total of 11 sherds, six are large enough to be identified as body sherds; the other five specimens are small fragments. No other parts of a ceramic vessel, such as a rim or shoulder, were recovered. One sherd fragment was found in level 1 (plowzone) of XU101; all other specimens were collected from the site's surface. Four body sherds have cord marked exterior surfaces, two have smoothed exteriors; the interior surfaces of all six sherds are smoothed. It is interesting to note that the cord marked sherds are tempered with either limestone or indurated clay, whereas the plain sherds are tempered with sand (Table 4.42). The

Table 4.42. Ceramic surface treatment compared with temper (14BU30).

	Limestone	Indurated Clay	Sand
Cord Marked	2	2	-
Smoothed	-	-	2

two kinds of sherds differ slightly in other respects as well, the temper in smoothed sherds is more concentrated than particles in cord marked sherds, and the surface colors of smoothed specimens are reddish rather than light to dark brown as on cord marked pieces. The significance of these observations can not be inferred from so small a sample, but the same pattern has been observed in ceramic collections from other sites at El Dorado Lake. The different surface treatments and tempering agents are associated with occupations by Woodland and Plains Village peoples, respectively. What little ceramic evidence there is from 14BU30 suggests that it was a two component site; the projectile point forms discussed in the paragraphs below support this view.

As has been the case with the three sites already discussed in this chapter, chipped stone artifacts comprise the numerically largest raw material class. Since the ceramic evidence presented above indicates that two culturally different components were deposited on 14BU30, the artifact classes enumerated in Table 4.43 can not be considered as interrelated components of the same lithic technological subsystem. An examination of the table shows that nearly all of the technological classes of interest are represented by artifact members. However, the six surface collection sweeps and the excavations were not very productive; there are 809 specimens available for study in the collection.

Information on raw material procurement practices will have to be gleaned from an examination of cores, debitage, and retouched tools. No pieces of unmodified raw chert were found, but there are two blocks of chert that were tested and transported to the site. Both specimens are cortical, neither was heat treated, and one is of Florence chert, the other is Foraker.

Table 4.43. Chipped stone artifact counts (14BU30).

Class	Number
Unmodified Raw Materials	-
Tested Raw Materials	2
Cores and Core Fragments	32
Chunks and Shatter	136
Complete Flakes	82
Proximal Flake Fragments	187
Other Flake Fragments	348
Resharpening Chips	1
Potlids	8
Utilized Blanks	1
Unifaces	2
Bifaces	10

The core and core fragment data demonstrate the prehistoric use of an additional chert variety, i.e., the local light gray (Table 4.44). There are 14 cores and 18 core fragments. All of the cores had flake blanks struck from them. They have no blade detachment scars and none of them exhibit thermally induced color changes. The six cores with single striking platforms, the single ended core class, have cortex on at least one surface; two of them made from Florence chert exhibit a nodular precore form. A single ended core of light gray chert has a large rounded surface covered with brown patina; it was a large piece of gravel probably picked up in a stream bed. The polymorphic and discoidal cores also have at least one cortical surface; none of these artifacts have determinate precore forms. The last core is a ridge-ridge bipolar core; it is made of light gray chert, is noncortical, and is an exhausted nucleus. Striking platform treatments observed on cores include single faceted (or plain), multiple faceted, unprepared cortical, unprepared patinated, and a combination of plain and dorsal reduction. All but three core fragments are partially cortical. One Florence and three Foraker specimens have thermally altered surface colors, and may have been used as hearth stones, boiling stones, or roasting pit heat sources. Their heat discoloration may also have been fortuitous; in the absence of associational and contextual data, a more specific function cannot be offered.

Table 4.44. Cores and core fragments (14BU30).

Chert Type	Core Type Single Ended	Polymorphic	Discoidal	Bipolar	Fragment
Florence	4	3	1	-	7
Foraker	1	1	-	-	9
Light Gray	1	-	2	1	2

A study of chunks and shatter add more chert varieties to the list of chippable rock found at 14BU30 (Table 4.45). There is one specimen of Westerville chert and three artifacts are in a residual miscellaneous category. The data presented in Tables 4.44 and 4.45 show that the same chert types encountered on other El Dorado Lake sites were also brought to 14BU30. That some cherts are not represented by cores or selected raw materials suggests that members of those classes may have been brought to the site and carried away again, or that the cherts were brought to the site in blank, preform, or tool form. Chunks and shatter are interpreted as by-products of heavy hard-hammer percussion; their presence implies core preparation and blank detachment, all of which suggests that the chert varieties in question were brought to the site in the form of raw materials or prepared cores. There is an extremely high proportion of chunks and shatter made of Florence and Foraker chert relative to the light gray variety (Table 4.45), yet all three cherts are available locally. Also, it can be seen that the Florence artifacts are preponderantly cortical, but about even with regard to heat treatment, whereas Foraker chunks

Table 4.45. Chunks and shatter (14BU30).

Chert Type	Cortex Heated	Cortex Not Heated	No Cortex Heated	No Cortex Not Heated
Florence	23	29	3	9
Foraker	20	6	27	9
Light Gray	-	2	3	1
Westerville	-	-	1	-
Miscellaneous	-	2	-	1

and shatter are mostly thermally altered, but about even with regard to the presence or absence of cortex. The significance of these highly variable relative frequencies is not clear. The interpretations offered above for core fragments may apply to chunks and shatter as well. Sampling error may also be a factor influencing these anomalous ratios, especially in such a small surface collection. Most Florence chunks and shatter are larger than Foraker specimens. This size variation may mean that a different knapping technique was used to work Florence chert or that, given the same technique, Florence chert broke apart under impact more often than Foraker.

The debitage data show that Foraker chert was by far the most common variety knapped at 14BU30 (Tables 4.46, 4.47, 4.48). The extremely high proportions are in direct contrast with those discussed for cores, chunks, and shatter where Florence and Foraker frequencies were about even. It is perhaps the case that Florence chert was used to manufacture large heavy tools, such as axes or choppers, and that Foraker chert was chosen for the manufacture of smaller lighter tools, such as scrapers, knives, or projectile points. This interpretation could also account for the radically different chunk and shatter ratios noted above, particularly if Foraker blanks and preforms were being heat treated in preparation for final shaping by pressure retouch.

Table 4.46. Complete flakes (14BU30).

Chert Type	Cortex Heated	Cortex Not Heated	No Cortex Heated	No Cortex Not Heated
Florence	-	2	1	5
Foraker	11	11	29	13
Light Gray	-	1	-	2
Miscellaneous	-	4	-	3

The majority of complete flakes are Foraker chert (Table 4.46). Cortical Foraker flakes are quite large, i.e., they are core trim flakes or blanks; thermally altered specimens are nearly all (8 of 10) trim flakes with very irregular and completely cortical dorsal surfaces. Noncortical Foraker flakes are small to medium in size and probably represent retouch by-products. Complete flakes of Florence, light gray, and miscellaneous chert are rare and generally not heated. However, nothing is known about the cherts lumped together in the miscellaneous category; for example, it is not known if or how the colors of such cherts change when exposed to sufficient heat.

Table 4.47. Proximal flake tragments (14BU30).

	Cortex		No Cortex	
Chert Type	Heated	Not Heated	Heated	Not Heated
Florence	2	-	1	7
Foraker	14	15	79	26
Light Gray	1	-	3	13
Westerville	1	1	-	1
Miscellaneous	-	6	-	17

The observations, comments, and interpretations discussed for the complete flakes apply also to proximal flake fragments and other flake fragments (see Tables 4.47 and 4.48). The proportion of chert varieties and the observed presence or absence of cortex and thermal alteration form a consistent pattern in the three debitage classes; these data suggest very strongly that Florence and Foraker chert were differentially procured and sequenced in the chipped stone tool production technology at 14BU30. Striking platform treatments observed on complete flakes and proximal flake fragments are identical to those reported for the cores (see above). There are eight potlids not included in the debitage tabulations (6 Foraker and 2 Florence); their presence in the collection demonstrates that chert was thermally altered on the site. A single resharpening chip of unheated, noncortical, light gray chert was collected from the surface; it is a small proximal flake fragment. The edge formed by intersection of striking

Table 4.48. Other flake fragments (14BU30).

	Cortex		No Cortex	
Chert Type	Heated	Not Heated	Heated	Not Heated
Florence	6	9	7	30
Foraker	31	19	175	47
Light Gray	1	1	2	11
Westerville	-	1	2	-
Miscellaneous	-	2	-	4

platform and dorsal surface is very rounded; step facets originating at that edge occur on both adjacent surfaces. No polish or striations were observed. The artifact was probably produced by biface resharpening.

The lithic collection contains 13 tools (Table 4.49); all of the bifaces are broken. Eleven tools are made of Foraker chert, nine of which have been heat treated. Two bifaces are made of light gray

Table 4.49. Chipped stone tools (14BU30).

	Chert Type	
	Foraker	Light Gray
Utilized Blank	1	-
Unifaces		
Side Scraper	1	-
Notch	1	-
Bifaces		
Projectile Point	5	-
Knife	-	1
Fragment	3	1

chert. The frequency of light gray in the tables presented above was so low relative to Foraker and Florence that the recovery of bifaces made from the light gray type is somewhat surprising. The proportionately low frequency of light gray chert in the entire collection could not be due to sampling error. Since that variety is the easiest to see in a plowed or vegetation covered field, its light color would actually tend to bias recovery in its favor and result in overrepresentation.

The utilized blank (Fig. 4.28a) is a large Foraker flake fragment without a striking platform. The tool was not retouched, but has wear on its distal and lateral edges. The right lateral edge, in particular, has heavy bifacial step faceting (that is, stepped facets occur on both the ventral and dorsal surface, and the facets originate at the edge), surface polish, and edge rounding from use. Step faceting has produced a serrated working edge; no striations were visible under a 70 diameter magnification. The wear and serrated edge suggest the tool was used as a saw.

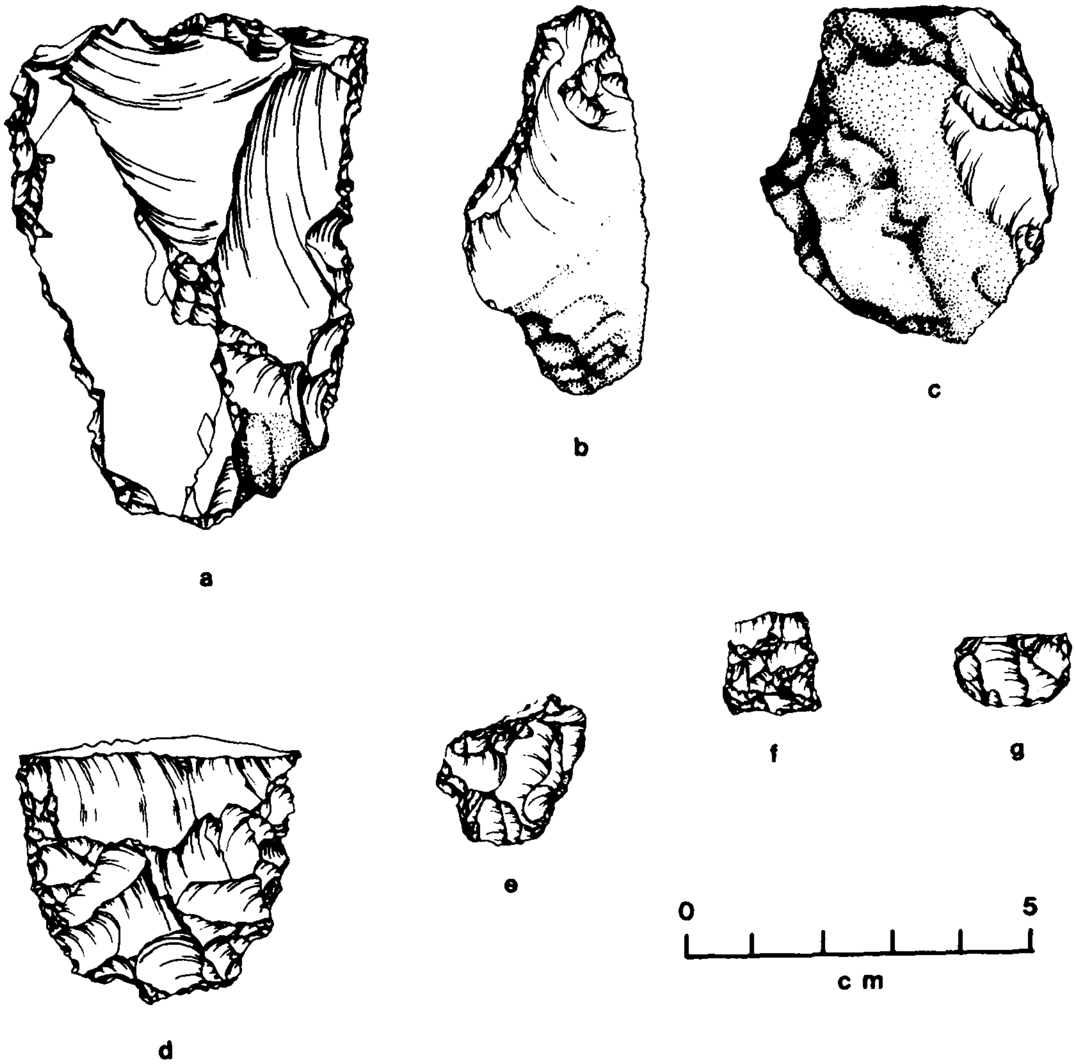


Figure 4.28. Chert tools from 14BU30: (a) utilized blank (A5000477-237), (b) notch (A5000477-226), (c) side scraper (A5000477-228), (d) biface fragment (A5011277-5), (e,f,g) projectile point bases (A5000477-354, A5000477-285, A5000477-451).

The two unifacially retouched tools are a side scraper and a notch. The notch, or concave scraper (Fig. 4.28b), has retouch flakes driven from the ventral flake surface along the left lateral edge. The tool is made of Foraker chert, is heat treated and partially cortical. The working edge exhibits rounding and step faceting characteristic of scraper wear. The side scraper (Fig. 4.28c), also a Foraker flake, heated, and partially cortical, has retouch flakes driven from the dorsal surface along the right lateral edge. It too exhibits typical scraper working edge wear. Neither uniface was modified for attachment of a haft.

As noted above, none of the bifaces are complete; they all have breaks. Five specimens are small and thin; they are projectile point fragments and all are made of heat altered Foraker chert. One point fragment is a medial segment with both the tip and base broken off; there is an impact fracture where the tip used to be. Three fragments are bases without tips; two have convex basal edges and one is straight (Fig. 4.28g, f). A fifth artifact is an incomplete point. The convex base was bifacially retouched, but work was terminated on the left lateral edge because of a break (Fig. 4.28e). The base was also damaged by farm machinery. Three fragments are pieces of small triangular points which are common on Plains Village components at El Dorado; the fourth fragment represents a corner notched point associated with Woodland components.

The remaining biface fragments are larger and thicker than those described above; two are quite thick and may be axe, chopper, or some other kind of heavy tool fragment. Two others are moderately thick and appear to be knife or preform fragments. Neither of the latter have worn edges; the example illustrated in Figure 4.28d is made of light gray chert. A final biface fragment is also made of light gray chert. The specimen is narrow and has an impact fracture on its narrowest end; it is probably a medial segment of a large projectile point with both the tip and base broken off.

The pattern of chert thermal alteration found on El Dorado sites previously discussed is evident also at 14BU30. The data suggest that flake blanks and bifacially retouched preforms were heat treated as a preparatory step for final shaping. Cores and selected raw materials were not thermally altered as part of a tool production process. Thermal pretreatment of blanks and preforms accounts for the mixture of heated and unheated debitage. Twelve of 13 chert tools exhibit thermally induced color changes. Thus, heat treatment was not a universal technological step, but it was quite common. Thermal alteration of core fragments, chunks, and shatter cannot be accounted for by positing the above tool manufacturing sequences. Such artifacts are lithic by-products that were no longer usable except as hearthstones, boiling stones, or radiant heat sources in roasting pits.

Site Summary and Discussion

14BU30 is a double component site of uncertain size and dimensions; it may be composed of several small areas of surface debris concentrations. The site is situated on the surface of Walnut River's first terrace above floodplain. Cultural deposits have been destroyed by cultivation; there are no known intact components below the plowzone. All recovered artifacts came from either the surface or the plowzone; the collection contains burned earth, limestone, sandstone, pottery, and chipped stone. Since the site was destroyed by plowing, soil samples taken for water flotation and screening were not processed.

The recovery of burned earth, limestone, and pottery suggests that food was cooked and consumed prehistorically at 14BU30. A sandstone mano indicates that plant products, such as seeds or nuts, were part of the diet. An analysis of chipped stone showed that raw materials were procured and transported to the area. Several different kinds of core were prepared from which flake blanks were detached. Blanks and preforms were thermally pretreated and then were either used in that form or subsequently retouched into unifacial or bifacial tools. Cores and unprepared raw materials were not thermally altered during the manufacturing sequence. The tool collection is composed of a utilized blank saw, a notch and side scraper, some knife fragments, and a few small projectile point fragments. A consideration of chunks, shatter, and striking platform treatments on cores and debitage demonstrated that prehistoric flint knappers used several different chipping techniques. Thermally induced color changes on core fragments, large chunks, and shatter were interpreted as evidence that some of these items may have been used as hearthstones, boiling stones, or as heat sources in roasting pits. Heat discolored limestone and burned earth also indicate the former presence of hearths and/or roasting pits.

The functions of 14BU30 in terms of subsistence and settlement systems is difficult to infer because of the meager data and the mixture of a Woodland component with a Plains Village component. The scarcity of artifacts and their apparent concentrations suggest that the area was occupied intermittently for relatively short periods by a small number of people. The artifact assemblage, however, demonstrates that chert tools were manufactured and repaired, and that food was processed, cooked, and consumed. The tool collection indicates that hunting and gathering subsistence activities were conducted. There is indirect evidence for the former presence of hearths and roasting pits. Ceramic vessels were used, probably for cooking, but there is no evidence to suggest pottery was made on the site. No evidence for the presence of prehistoric houses was found, so the site was probably not a village. The pottery sherds and mano imply that occupation was more substantial than a transitory hunting-gathering camp; it may have been a semi-permanent campsite occupied to exploit seasonally available plant and/or animal food items. This inference is a reasonable guess rather than a substantiated conclusion. One thing is certain though, and that is that the artifact assemblage is less variable than expected for a village and more variable than expected for a hunting camp. Manos are not generally expected to occur in transitory hunting camp assemblages.

The results obtained from test excavations demonstrate that a future salvage excavation on 14BU30 is not justified. It is recommended, however, that site boundaries and the number of internal subareas be determined more accurately. An increased artifact sample would also be very useful for comparative studies when more Woodland or Plains Village sites are investigated. Such additional information can be gathered easily from the surface, if the site is cultivated again.

14BU27

Description

14BU27 is located on the surface of the first terrace above floodplain on the north bank (right side) of Satchel Creek 300 m. east of the creek's confluence with Walnut River. It lies directly across Satchel from, and to the northeast of, 14BU57 (Fig. 4.2). Although not threatened by imminent construction, the site will be inundated by El Dorado Lake's multipurpose pool. 14BU27 was first recorded and investigated in 1967. Eoff and Johnson (1968) reported burned rock and chert chips scattered over an area estimated as 5 acres. A Woodland cultural affiliation was suggested on the basis of a sand tempered, cord marked pottery sherd. The site was not examined again until the present study. Field work was conducted after rainfall when the Walnut River was too high to ford; 14BU27 was a wet weather site in 1977, i.e., easily accessible during poor working conditions.

The site lies in a large tilled field which had been systematically searched for cultural debris by the reconnaissance crew (Root, this volume, Chapter 2). Several visits were made to gather data on surface debris concentrations and distributional limits before test excavations were started. On these occasions it was noted that surface artifacts were so scarce that a grid controlled surface collection would not be productive and could not be justified. The field was tilled in early September to prepare it for winter wheat; this fresh turning of the soil and timely rains did not alter earlier information on debris density or judgments about the value of a gridded surface collection. Therefore, as much surface material as could be found was collected by sweeping the surface after each thunderstorm. The information on site size and boundaries offered below was gathered during these surface collecting expeditions.

A contour map was prepared with a transit. 14BU27 occurs near a sharp bend in Satchel Creek; the creek is presently less than 20 m. southeast of the site (Fig. 4.29). No artifacts were found eroding out of the cutbank, so it could not be ascertained if Satchel Creek was cutting into the site and the terrace it lies on. The upper site area has about 1.25 m. of relief. The terrace's surface is generally quite flat, except that there are undulations caused by flood scouring. Relief shown on the site map is related to runoff erosion. Satchel Creek normally flows 4.5 to 5.0 m. below the site's present surface.

Artifact visibility was excellent in the plowed field. During the surface collection sweeps mentioned above, it was determined that surficial debris extends, maximally, 200 m. east to west and 195 m. north to south. Total area is 24,800 sq. m. or about 2.5 ha. The estimated amount of error associated with these dimensions is ±10%. Material density was greater on higher site elevations in the vicinity of site reference; it thinned out gradually toward posited site limits to the north, west, and south. There were no apparent internal subareas of concentration that could be linked to prehistoric cultural behavior.

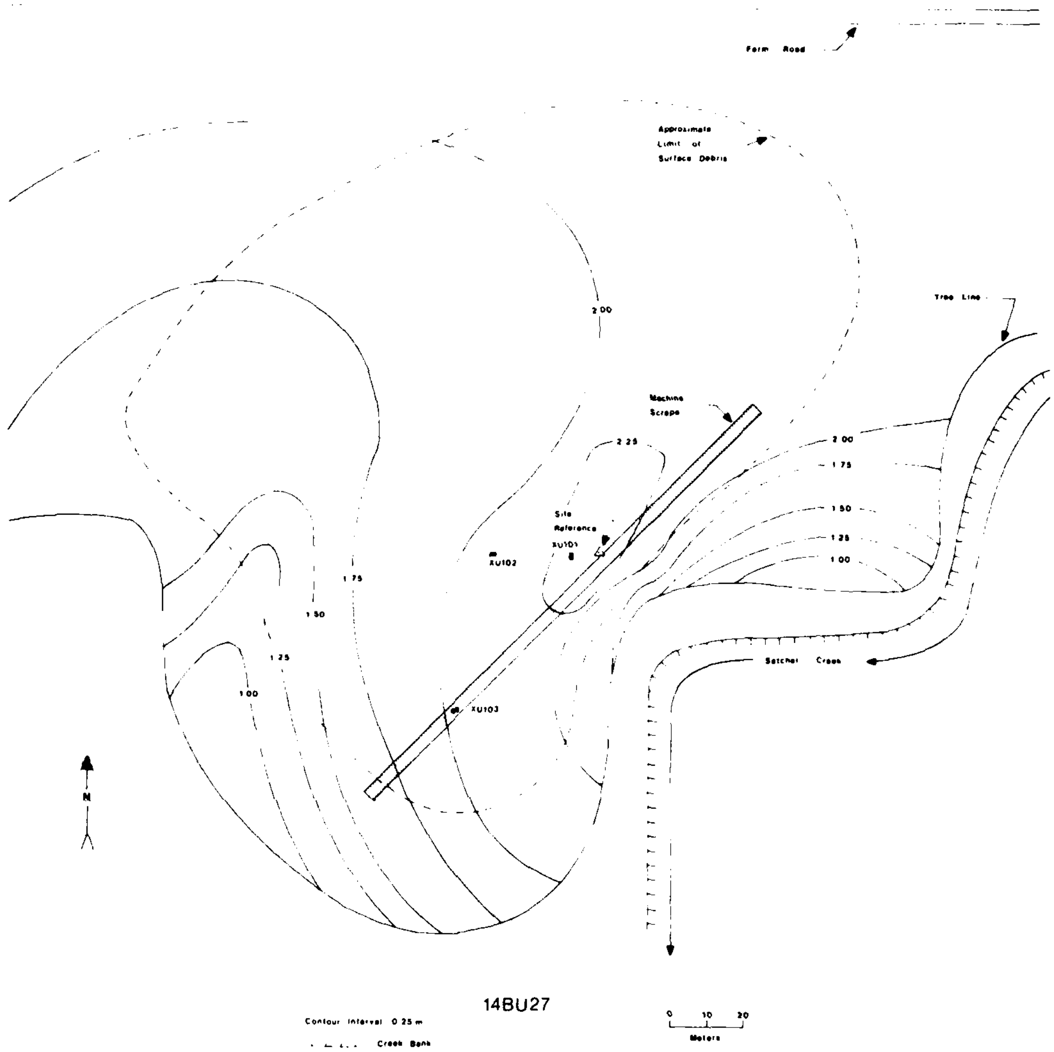


Figure 4.29. Contour map of 14BU27 showing the location of earth mover scrape and test excavations.

A two meter grid system was set up on the map; site reference was arbitrarily designated 100N100W to insure that all possible on site grid coordinates were in the northwest quadrant. Rather than work in 2 by 2 m. squares, 1 by 2 m. exploratory test trenches were laid out. This adjustment decreased the area and volume of each excavation unit by half, but allowed the placement of more units on the site. XU101 (98N108W) was placed in an area of high surface artifact density near the southeast boundary; it was set on the grid system with its largest dimension in a north to south direction (Fig. 4.29). In order to speed up work and finish before wheat was planted, backdirt was not screened through a sifter. The soil was too muddy to sift anyway, so the excavated matrix was searched manually to recover missed artifacts.

XU101 reached a depth of 50 cm. below ground surface; a 20 cm. plowzone taken out as a single unit was followed by 3 lower levels of 10 cm. each. The plowzone consisted of a loose, very dark grayish brown soil that contained burned and unburned wheat stubble, pieces of chipped stone, burned earth, limestone, and one pot sherd. Level 2 (20-30 cm.) produced even more chert chips, limestone, and burned earth, but no pottery; and, in addition, burned and unburned bone fragments and a charred walnut hull (*Juglans nigra*) were found. The soil in level 2 was also very dark grayish brown. Artifact counts in level 3 (30-40 cm.) decreased and the soil got lighter in color. At a depth of 43 cm. in level 4 (40-50 cm.) the soil had become dark grayish brown, mottled with even lighter colors, and cultural material had all but disappeared (Table 4.50). Vertical artifact distributions and soil

Table 4.50. Depth distribution of artifacts in XU101 (14BU27).

Level	Chipped Stone	Burned Earth	Limestone	Pottery	Fauna	Flora
1	30	11	66	1	-	-
2	75	66	142	-	22	3
3	10	2	11	-	3	-
4	1	-	1	-	-	-

color changes demonstrate that there is an intact subplowzone cultural horizon on 14BU27. More limestone and burned earth fragments were observed in levels 2 and 3 than could be recovered; charcoal flecks were also very common. All of this material was very small and fragmentary. No culturally or chronologically diagnostic artifacts were found below the plowzone.

XU102 (99N128W) was staked out 20 m. west of XU101 in an attempt to determine if the intact cultural deposit extended in that direction (Fig. 4.29). It was reasoned that runoff erosion and plowing may have deposited more topsoil over this site area and that the cultural deposit might be deeper and, therefore, less disturbed, by cultivation. XU102 was excavated in the same manner as XU101. Level 1 took out the 20 cm. plowzone; 3 additional levels of 10 cm. each were excavated to a total depth of 50 cm. Vertical artifact distribution is somewhat different in XU102 (Table 4.51); artifact counts are lower in every level and decrease steadily before finally disappearing altogether below 40 cm. No ceramics or charred flora were recovered, but the usual small charcoal flecks and tiny pieces of burned earth were observed throughout the top 3 levels. The results from excavation of XU102 indicate that decreasing surface concentration in this site area accurately mirror the frequency of subsurface material. The data show that

Table 4.51. Depth distribution of artifacts in XU102 (14BU27).

Level	Chipped Stone	Burned Earth	Limestone	Fauna
1	11	2	24	1
2	9	6	3	30
3	8	1	-	4
4	-	-	-	-

a subplowzone deposit exists, but is less concentrated and probably thinner than in the vicinity of XU101. No culturally or chronologically diagnostic artifacts were found in XU102.

Having demonstrated the existence of an intact cultural deposit, the next step was an attempt to determine if there were any features in the best preserved portion of the site. An earth mover was used to scrape away the plowzone in a swath 3.5 m. wide and 150 m. long; the scraped path was staked out along the southwestern boundary of surface debris so as to pass through the high density area around site reference (Fig. 4.29). The swath was not aligned with the grid system because the machine needed enough room to maneuver. The earth mover scraped away almost all of the plowzone; the fresh surface was, of course, not level, but 20 to 25 cm. of topsoil was removed in three passes. The scraping uncovered 43 pieces of limestone, 2 pieces of chert, 2 bone fragments, and a pottery sherd. Burned earth and charcoal flecks were common.

The earth mover also uncovered a number of small circular soil stains northeast of site reference. When these possible feature stains were cross sectioned they turned out to be rodent burrows and tree roots. Most of the uncovered limestone and burned earth was scattered randomly in the scrape path, except for a concentration of burned earth and charcoal near the southwest end. The concentration resembled a hearth, so XU103 (55N139W) was placed over it so as to continue excavation by hand (Fig. 4.29). The test unit was levelled to a uniform 20 cm. below unscraped ground surface and troweled clean. The feature (designated feature 303) exhibited a diamond shaped area of high concentration and a larger, more inclusive triangular shaped area of lighter concentration (Fig. 4.30). Feature 303 was darker than surrounding matrix because of numerous charcoal flecks. It is an irregular concentration of burned earth and charcoal. The interior concentration measured 27 cm. north-south and 20 cm. east-west; the larger and less dense concentration was 53 cm. north-south and 42 cm. east-west.

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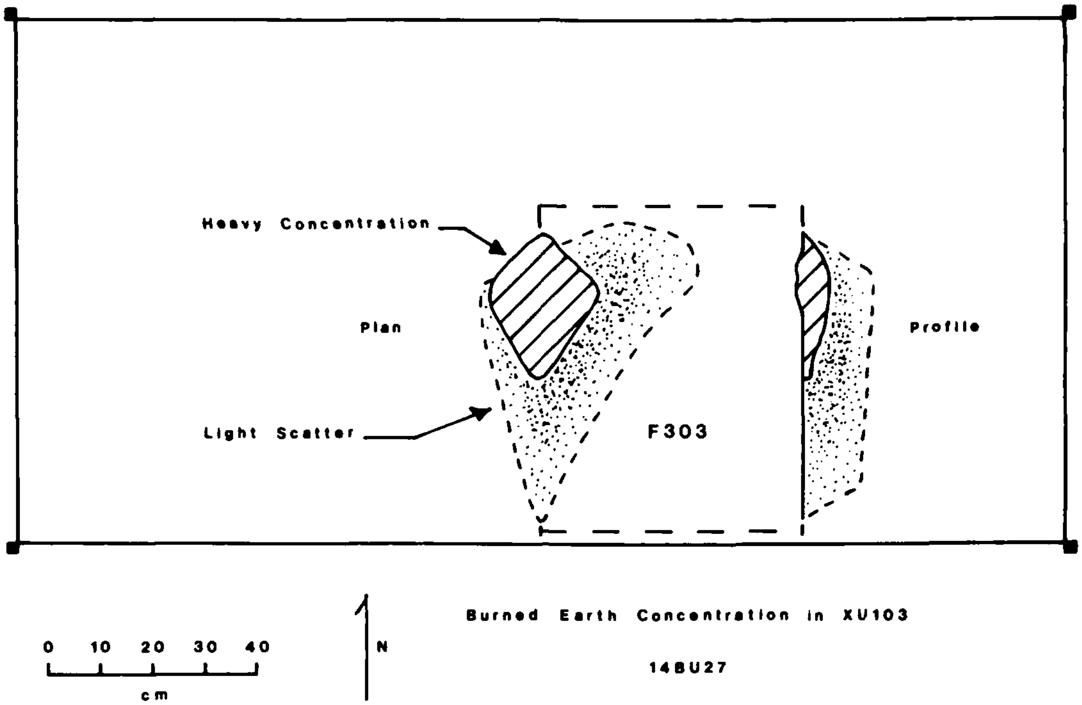

Figure 4.30. Feature 303 plan and profile, XU103 (14BU27).

Feature 303 was cross sectioned by excavating the eastern 1 by 1 m. square in XU103. The square was dug to a depth of 50 cm. below unscraped ground surface. In general, the same sort of midden debris and soils were encountered during this work that were described above for XU101. The cross section revealed that feature 303 had a total depth of 14 cm.; the densest part of the concentration was 5 cm. deep. No pit walls were detected and there were no structural changes apparent when feature matrix was compared with exterior soil matrix. Burned earth and charcoal gradually disappeared (Fig. 4.30) so feature limits are indicated by a dashed line. Since there is no evidence demonstrating that feature 303 was a trash filled pit, it can be interpreted as a concentration formed by prehistoric trash disposal. Feature matrix was collected and taken to the laboratory for water flotation and screening; it contained burned earth, charcoal, a small bone fragment, and many small pieces of limestone.

A conclusion which may be drawn from the machine scrape and hand excavated test pits is that 14BU27 has a horizontally extensive subplowzone deposit. The occupation layer is visible in profile as a very dark grayish brown horizon (Fig. 4.31) that is about 40 cm. deep; the top 20 cm. have been disturbed by cultivation. Since the test trenches were only excavated to 50 cm. below ground surface, a posthole auger was used to drill through the sediments for an additional meter of depth in XU101 and XU103. No artifacts or cultural horizons were found to a depth of 150 cm.

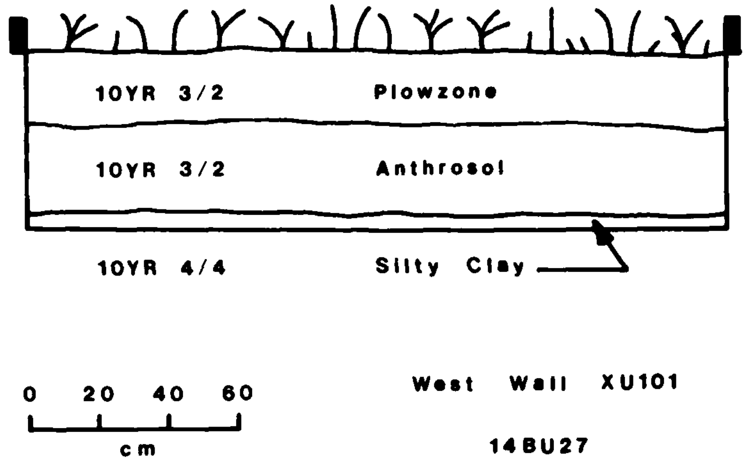

Figure 4.31. West wall profile from XU101 (14BU27).

Artifact Analyses

Since no culturally or chronologically diagnostic artifacts were recovered below the plowzone, the small sample of excavated artifacts will be presented and discussed with surface collected material. It will also become apparent in the paragraphs which follow that 14BU27 is a single component Woodland site, so there is no need to discuss surface and subsurface material separately. The artifact collection includes sandstone, limestone, burned earth, charred flora, bone, ceramics, and chipped chert. None of these raw material classes are represented by large artifact samples, this is somewhat encouraging because it may mean that most of the occupation zone is undisturbed. It is possible that the site was at one time partially buried under a sterile layer of sediments and that plowing and erosion have disturbed only the uppermost portion of the cultural layer. On the other hand, surface debris could also be sparse because of relic hunting.

A single piece of sandstone was recovered in level 4 (40-50 cm.) of XU102. The cultural origin of the specimen can be questioned because it is small (4.9 gm.) and rounded like the gravel on the site. However, it also appears to have been burned, but is not otherwise modified. Until a better comparative sample of unquestionably used prehistoric sandstone is obtained in the El Dorado locality, the significance of the specimen from 14BU27 is indeterminate.

Limestone was not as common on the surface as had been experienced on the other sites. This is, of course, a subjective impression, since surface limestone was not systematically sampled. The smaller number, yet greater total weight, of surface compared to excavated specimens shows that there was a surface collection bias toward large pieces (Table 4.52); even these figures are badly skewed because one unburned chunk of limestone from the surface weighs over 2,200 gm. In general,

Table 4.52. Limestone counts, weights, and distribution (14BU27).

	Number	Weight (gm.)
Surface Collected		
Burned	16	1,264
Not Burned	15	2,813
Excavated		
Burned	20	227
Not Burned	229	639
Site Totals		
Burned	36	1,491
Not Burned	244	3,452

limestone occurs as small fragments; excavated pieces are very small. Burned specimens were probably used as hearthstones or roasting pit heat sources. None of the limestone fragments had an intentionally modified or shaped surface.

The presence of burned earth in artifact collections has been discussed and interpreted cautiously throughout this chapter. Pieces of burned earth were also found on 14BU27. All but one specimen were recovered in test excavations; the 90 fragments weigh 77.4 gm. Each was inspected under a microscope for temper, wattle or grass impressions, and sherd surfaces. No temper or wattle impressions could be found, but one large piece of burned earth has a smooth surface that is well oxidized by heat. A closer examination showed that not only is the surface smoothed, it is also well compacted. The artifact is not a pot sherd for two reasons: (1) it is much thicker than any sherd collected from El Dorado sites and (2) sherds from 14BU27 that have smoothed surfaces are tempered with sand, whereas the piece of burned earth contains no sand.

Three alternative hypotheses may account for a smoothed and compacted surface on a piece of burned earth. Two possibilities, known from later time periods in the eastern United States, puddled clay floors (as in houses or temples) and prepared clay hearths, have not been recorded in the El Dorado area (Fulmer 1976, 1977; Bastian 1978; Grosser 1970, 1977). Daub, the third possibility, has not only been recovered in the area, but is associated with a prehistoric Woodland house (Fulmer 1977). A single piece of burned earth with a smoothed and compacted surface is, admittedly, slim evidence for the former

presence of a dwelling, but it is the only evidence available. Thus, it may tentatively be suggested that the specimen in question is a piece of daub and that it may have come from a dwelling.

The artifact collection includes a fairly large sample of bone; the sample is not overwhelming, but is the second largest faunal collection retrieved from the sites tested in 1977. All of the skeletal material is fragmentary, well preserved, and all of it was recovered in test excavations. About 25% of the 55 pieces (total weight 19.8 gm.) is charred or calcined. The bone fragments are pieces of large mammal long bones, one specimen is a cervid (possibly deer) metapodial fragment. None of this material retained diagnostic characters, so identifications cannot be more precise. As was the case on 14BU57, it appears that long bones were smashed into bone meal to extract fat and marrow.

It has already been mentioned that a charred walnut hull (Juglans nigra) was recovered in level 2 of XU101. Two uncharred pieces were also found in that particular level; they may be intrusive. Soil samples (17.5 l.) were taken from levels 3 and 4 of XU103 as well as the burned earth and charcoal concentration (feature 303). Recall that the feature was interpreted as trash dumping debris, so it seemed to offer a good opportunity to recover a sample of charred flora. Water flotation and screening produced only one identifiable plant part, a charred Chenopodium seed from level 3. All three processed samples, of course, contained charcoal flecks, burned earth, limestone fragments, and small pieces of chert debitage. While these results are disappointing, the walnut hull, nevertheless, demonstrates that there are prehistoric plant remains on the site and that charred walnut hulls, at least, are well preserved.

The pottery sample is composed of 9 body sherds and 2 small fragments. All ceramics came from either the surface or plowzone; 3 specimens were recovered in excavations. The sample contains no rim, shoulder, neck, or basal sherds, so there can be no inferences made as to vessel shapes or sizes. Eight body sherds and the two fragments are tempered with large quantities of sand; sherds have smoothed over cord marked exterior surfaces and plain smoothed interior surfaces. Exterior surface colors are red or brown, cores are gray to dark gray, and interior surfaces are dark gray to black. From the color distributions it can be inferred that vessels were fired in a hot oxidizing fire; the dark colored interiors, some of which still have charred organic matter stuck to them, indicate that ceramic vessels were used to cook food. One body sherd is tempered with indurated clay; its interior and exterior surfaces are plain smoothed; and its surface and core colors are uniformly dark gray. Ceramics from 14BU27 are similar to sherds found on other Woodland sites in the project area and indicate that the site is a single component Woodland occupation (Table 4.53).

The lithic assemblage is rather small; 141 of 307 specimens were retrieved from test excavations (Table 4.54). Most of the chipped stone artifact classes have small numbers of elements or none at all. Selected raw material is represented by a single large piece of tested raw material: a river rolled cobble of light gray chert. The artifact

Table 4.53. Body sherd surface treatment and temper (14BU27).

Temper	Surface Treatment	
	Cord Marked	Smoothed
Sand	8	-
Indurated Clay	-	1

Table 4.54. Chipped stone artifact distribution (14BU27).

Class	Surface Collected	Excavated
Unmodified Raw Materials	-	-
Tested Raw Materials	1	-
Cores and Core Fragments	6	2
Chunks and Shatter	23	22
Complete Flakes	25	15
Proximal Flake Fragments	23	20
Other Flake Fragments	79	78
Resharpening Chips	-	1
Potlids	3	2
Utilized Blanks	-	-
Unifaces	1	-
Bifaces	5	1

was probably tested after it had been brought to the site. A flake detached to test the cobble intersected a large vug, after which the artifact was undoubtedly discarded as unsuitable for further processing.

The chipped stone collection contains 4 cores and 4 core fragments (Table 4.55). Three cores are polymorphic and the fourth is single ended; none of them were thermally altered. The single ended core was made from a nodule of Florence chert; it has a plain, but decorticated, striking platform. Two polymorphic cores were made from brown patinated river gravel; one is Florence chert, the other, Foraker. A Foraker core fragment is heat discolored; it may have been used as a hearthstone or a roasting pit heat source. Core fragments of Florence chert are cortical, but not heated. Notice that there are no cores made of light gray or Westerville chert in the collection (Table 4.55). The four complete cores are made of the most commonly used local chert varieties.

Table 4.55. Cores and core fragments (14BU27).

	Core Type		
Chert Type	Polymorphic	Single Ended	Fragment
Florence	2	1	3
Foraker	1	-	1

Most chunks and shatter are also local cherts (Table 4.56). Furthermore, most are large and have cortical or patinated surfaces, all of which indicates that they were produced when pieces of raw material were impacted. About half of the small pieces have thermally induced color changes; they may have been formed when chert was exposed to heat. Florence chert is more frequent than other cherts, this suggests that Florence either collapsed or broke more easily, or that it was processed with a different flint knapping technique.

Table 4.56. Chunks and shatter (14BU27).

	Cortex		No Cortex	
Chert Type	Heated	Not Heated	Heated	Not Heated
Florence	4	7	2	13
Foraker	-	4	7	1
Light Gray	-	1	3	1
Miscellaneous	-	1	-	2

Debitage is, for the most part, medium to small in size; there are few large pieces that could have been produced by block reduction or nodule splitting. What few large cortical specimens there are in the sample are either Florence or Foraker chert; those raw materials, then, were brought to the site and made into cores. Most of the debitage is small and represents waste from tool production or maintenance. Flakes and flake fragments of medium size probably resulted from blank detachment and core trimming. The tables (4.57, 4.58, 4.59) show that most specimens do not have cortical surfaces. For 14BU27, in general, it is the case that evidence for the processing of selected raw material is present, but not very common. Perhaps the initial stages of tool manufacture were conducted elsewhere, say at a quarry or workshop site, and

Table 4.57. Complete flakes (14BU27).

	Cortex		No Cortex	
Chert Type	Heated	Not Heated	Heated	Not Heated
Florence	-	8	1	5
Foraker	-	5	6	3
Light Gray	-	1	2	3
Westerville	-	-	-	1
Winterset	-	1	-	2
Miscellaneous	-	-	-	2

Table 4.58. Proximal flake fragments (14BU27).

	Cortex		No Cortex	
Chert Type	Heated	Not Heated	Heated	Not Heated
Florence	1	3	1	9
Foraker	2	7	7	4
Light Gray	-	1	1	3
Westerville	-	-	-	2
Miscellaneous	-	1	-	2

Table 4.59. Other flake fragments (14BU27).

Chert Type	Cortex Heated	Cortex Not Heated	No Cortex Heated	No Cortex Not Heated
Florence	-	15	5	27
Foraker	8	11	25	23
Light Gray	-	2	14	12
Westerville	-	-	2	2
Miscellaneous	-	2	1	8

prepared cores, blanks, and/or preforms were brought back for finishing. Florence and Foraker chert were used more often than other varieties. Nonlocal types occur in the form of Westerville and Winterset debitage; they indicate interregional exchange or contact with peoples in eastern Kansas. The incidence of thermal alteration is about as frequent as its absence; this also suggests that preforms and blanks were finished into tools on the site, but it is evident that heat pretreatment was not a universally applied preparation for tool production. Striking platform treatments observed on complete flakes and proximal flake fragments include unprepared cortical and patinated, plain, multiple faceted, and dorsal reduction.

One resharpening chip was found in level 2 of XU101; it is a proximal flake fragment of unheated Foraker chert. The edge formed by intersection of striking platform and dorsal surface is rounded, polished, and step faceted. The degradative wear and the specimen's small size suggest that it was removed to sharpen a scraper's edge. The potlid sample shows that Florence (2), Foraker (1), and light gray chert(2) were exposed to heat on the site, probably as a step in tool manufacture. Three other artifacts that are not included in the debitage tables are pieces of weathered or dissolved chert. All three pieces were excavated from level 1 of XU101. They are cracked and fragmented by heat, so they were probably used as hearthstones.

The chipped stone tool sample from 14BU27 is very small; there are no utilized blanks, one uniface, and six bifaces (Table 4.60). The unifacially retouched tool was made of heat treated light gray chert. Flakes were driven off the dorsal surface of a large flake blank from both lateral edges (Fig. 4.32a). The artifact's working end is missing, but it was probably a large end scraper. Its lateral edges are not worn or dulled through use. Three bifaces are too fragmentary to determine what kind of tool they may have been part of. All three have acute retouched edge angles and are very thin; they may be knife or projectile point fragments. Two were made of Foraker chert (one of which was heated); the third fragment is unheated light gray chert.

Table 4.60. Chipped stone tools (14BU27).

	Chert Type		
Tool Class	Florence	Foraker	Light Gray
Utilized Blanks	-	-	-
Unifaces			
End Scraper	-	-	1
Bifaces			
Projectile Point	-	1	-
Knife/Preform	-	1	-
Scraper	-	1	-
Fragment	-	2	1

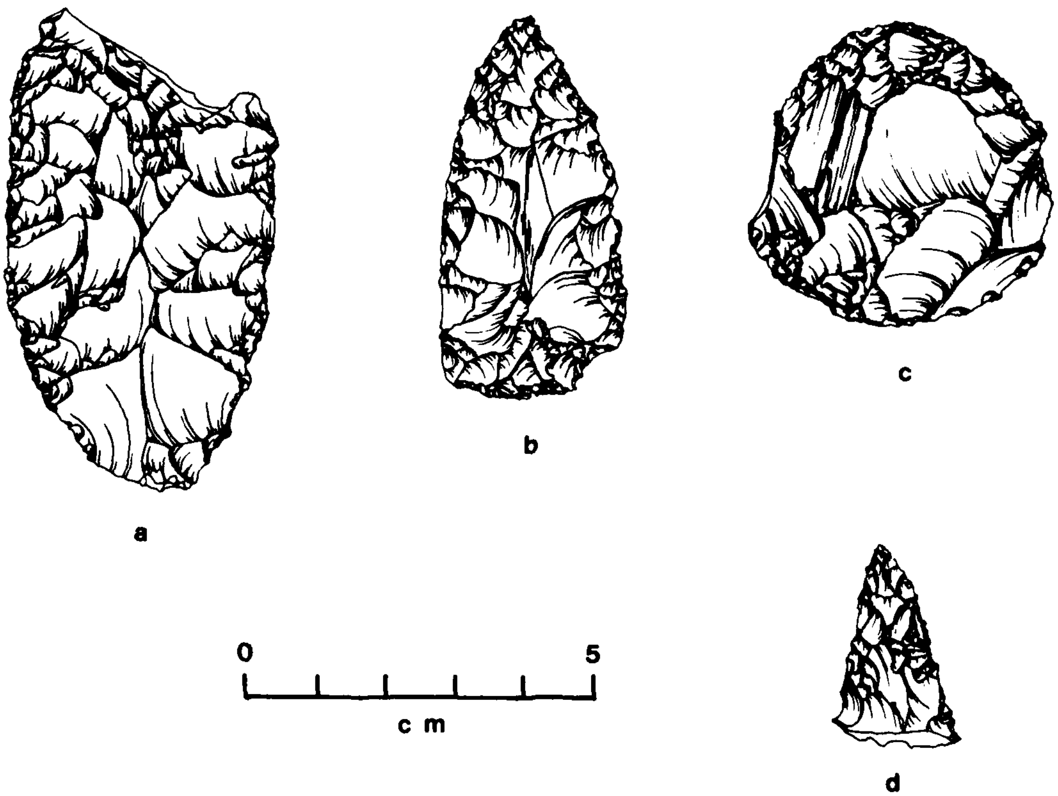

Figure 4.32. Chipped stone tools from 14BU27: (a) end scraper fragment (A5000177-279), (b) knife/preform (A5000177-232), (c) circular scraper (A5010377-14), (d) projectile point tip (A5000177-231).

Three other bifaces were made of thermally altered Foraker chert. One is the tip of a projectile point; it has an impact fracture for a break (Fig. 4.32d). The second artifact is complete except for a broken basal edge corner. It is triangular in shape, thin, and has very acute edge angles. Since the artifact is pointed and its lateral edges are not worn from use, it could be a projectile point preform or, simply, an unused knife (Fig. 4.32b). The last tool, also complete, is a discoidal core nucleus that has had one edge carefully shaped by retouch. The edge in question is rounded, slightly polished, and is step faceted; the artifact was used as a scraper. Flake detachment scars originate from all edges and cover both surfaces, so the modified discoidal core nucleus is classified here as a bifacial scraper. The distinction between end and side scraper is not appropriate in this case because the tool is nearly circular; there is no long or short axis (Fig. 4.32c).

Site Summary and Discussion

14BU27 is a single component Woodland site situated on Satchel Creek's first terrace above floodplain. The site covers about 2.5 ha. of area and has an extensive subplowzone cultural horizon that is 40 cm. thick; the uppermost 20 cm. of deposit were disturbed by plowing. Test excavations retrieved a small sample of well preserved bone, probably ungulate long bone fragments; charred flora may also be relatively well preserved. A piece of burned earth with a smoothed and compacted surface was cited as possible evidence for the former presence of houses. The pottery sample consisted of 9 body sherds, most of which had cord marked exterior surfaces and sand temper. The lithic assemblage contained few specimens associated with initial stages of raw material processing; most of the debitage and debris were related to core reduction and tool manufacturing sequences.

Small artifact samples are difficult to interpret, but the collection from 14BU27 is different from those reported for other sites in this chapter. The particularly noticeable differences are the scarcity of limestone and the lack of debitage representing the early stages of chert processing. An additional intuitive difference is the high density of burned earth, which may be daub fragments, and charcoal in the occupation zone. The limited number of recovered tools (two scrapers, a projectile point fragment, and a probable point preform) is also striking. All of these discrepancies are relative frequency differences derived from small surface collected samples, so they may not represent the 14BU27 component adequately. The tiny sample of chipped stone tools would certainly support the view that not enough is known about the site. If, however, the study collection is representative, it would indicate that 14BU27 is a different kind of Woodland site than those discussed earlier.

Artifact analyses suggested that plant and animal foods were prepared, cooked, and consumed. Fire cracked rock, burned limestone, and thermally altered chert demonstrate the former presence of hearths. Pottery vessels were probably used as cooking pots. The large amount

of burned earth and charcoal is either a product of hearth cleaning or debris left from burned dwellings, or a combination of both. Artifacts in the lithic assemblage indicate that tools were finished and maintained, but that the initial stages of raw material reduction were not frequent activities.

The site's laterally extensive, undisturbed deposit and the favorable preservation of floral and faunal remains suggest that 14BU27 be investigated further. The small artifact sample is a negative factor in the site's ranking vis-a-vis other tested Woodland sites, but is most likely a result of the small size of test excavations. In spite of a small artifact sample, the site is promising in terms of potential information content. Functionally, it could be characterized as a small hunting-gathering camp, a small village, or as some type of hamlet.

It is recommended that 14BU27 be given a relatively high priority excavation status. The site should not be assigned the highest ranking because not enough is known about it; there may be other Woodland sites tested in the future which will have similar undisturbed deposits without the disadvantage of associated small artifact samples. Additional surface collections can be conducted at 14BU27 to increase artifact samples and thereby strengthen the inferences that can be derived from them. A small amount of additional surface material could conceivably change the site's overall ranking up or down vis-a-vis other Woodland sites in the project.

CHAPTER 5

LATE QUATERNARY HISTORY AND PALEOGEOGRAPHY OF THE EL DORADO LAKE AREA, KANSAS

Darrell Drew

INTRODUCTION

This paper reports research on aspects of the natural history of the area to be flooded by the El Dorado Lake project northeast of El Dorado, Butler County, Kansas. Emphases have been placed on available references, and on the estimation of conditions at the time of initial white contact. The derived information is to be used as a springboard for an attempt to reconstruct as much paleoenvironmental history as can be accomplished in the remaining time before the area is inundated. These present and past locality models are to be related to human occupation and human resource use through time. In brief, the goal is to learn as much as possible of prehistoric man and his contemporary environment throughout his existence in the project area. This involves investigations dealing with: (1) the description of historic surface conditions (landforms, soils, climate, fauna, and flora), and (2) the description and interpretation of subsurface materials from the surface to the bedrock contact (landforms, sediments, stratigraphy, paleosols, and fossil faunal and floral remains). The latter study will include specific attempts to determine: bedrock configuration, regolithic components and limits, stream histories, terrace locations, organic sequences, unconformities, and dates. Although the Altithermal (see Reeves 1973 for an excellent recent discussion with extensive reference list) is unknown in this part of the Great Plains, evidence of it will be sought in the form of breaks in culture and/or sedimentation, along with associated dates.

For purposes of simplification and convenience, this broad interdisciplinary study has been broken down into categories with varying degrees of discreteness. Prehistoric conditions are lumped together under "paleogeography", whereas historic conditions are categorized as "geography" with the subfields of physiography, climate, soils, fauna, and flora. The historic period may be considered to have begun in the area with white contact about A.D. 1850. The Late Quaternary time span, of primary interest here, refers to approximately the last 25,000 years of geologic time, which probably more than delimits man's presence in the project area, and in the New World. Older Quaternary deposits, if present, may provide a more extended contextual framework.

The break between geography and paleogeography also separates emphases. It is evident from a consideration of the large area to be studied, the long time span, and the many specialized fields involved, that priorities must be established for anything of value to be ascer-

tained from this research. The subfields of the geography category, noted above, are areas of greatest knowledge, and should, therefore, be lower on the list of priorities. Physiography is known from topographic maps, climatic data are available, and extensive knowledge of the soils, fauna, and flora of the area have been recorded for the present (U.S. D.A. Soil Conservation Service 1975; U.S. Army Corps of Engineers 1972). Further, it is unlikely that the geographic conditions at the time of white contact differed much from those of the present (Joseph Collins, Vertebrate Zoologist, University of Kansas, Museum of Natural History, 1978: personal communication; A. W. Küchler, Professor of Geography, University of Kansas, Department of Geography, 1978: personal communication; Ronald McGregor, Professor of Botany, Director of the Herbarium and Director of the Kansas Biological Survey, 1978: personal communication). More will be said about this later.

Major emphases, then, should initially concentrate on those things least well known, and which must be studied before they are lost to the rising waters. Consequently, the recent geographic situation will be considered as an ancillary study to be given its due only when necessary to clarify pertinent specific problems relating to higher priority studies, and as a basis for building models related to the reconstruction of past conditions. Studies of present soils, for example, will be reserved for later unless it is determined beneficial to conduct tests along the way, for one reason or another. Present soils have been delineated and mapped within the area, and further detailed examination of them would be of little value, except possibly to attempt to relate current soil forming conditions and processes to past soils as a means of establishing similarities and differences in genesis. Phosphate and pH analyses could be performed to help determine horizontal and vertical limits of archeological sites, but these are limited in value and extremely time consuming if carried out correctly and in sufficient detail (Filer and Sorenson 1977:162). The time and effort might better be applied to more important and more reliable endeavors, at least for the forseeable future. It should be clarified that a soil, as used here, is a distinct geologic phenomenon that is an alteration of a pre-existing geologic unit caused by weathering, and which includes biotic components and supports plant growth (Haynes 1973).

It follows that the major emphasis ought to be on the paleogeographic category, and more specifically on the construction of a paleogeographic model for the El Dorado Lake area which can be related to human occupation. This model should focus on geologic deposits that represent the length of known human occupation in the New World (about the last 12,000 years), but it should also extend beyond, should older deposits be present, as is suspected. Paleogeography is a broad field that includes all of the elements of geography, plus more. In addition to searching for archeological sites older than those already known in the area, various geomorphic studies will be necessary as well. Sequences of Late Quaternary geologic events should be worked out, and climatic, faunal, and vegetational histories will need to be outlined. A major task will be to determine the presence of stream terraces for the Walnut River

and its tributaries, and then to work out their stratigraphic relationships, both internally and externally. Terrace information may lead to predictions as to the locations of earlier archeological sites. All presently known sites, and those yet to be discovered, need to be related to geomorphic situations and to their contemporary climatic, faunal and floral affiliations. And, of course, all sites need to have their time parameters calculated as closely as possible. The determination and distribution of sources of water and mineral resources are other important considerations. Thus a search for springs, prehistoric lakes and ponds, and various rock and mineral sources such as chert, sandstone, clay, hematite and quartzite, is pertinent. Correlation with other projects such as chert studies (see Chapter 7, this report) and archeological site testing (see Chapter 4, this report), as well as with major site excavations is considered an important and necessary adjunct to the overall paleogeographic study. Experts in specific subjects will be called upon for their assistance as needs arise.

RESEARCH METHODS AND RESULTS

Because of the wide range of subjects, and because the subjects deal with observations that could only have come from actual field work, data delineation seemed to demand more than a simple library search. Therefore, as a first step, personal interviews were conducted with all known pertinent authorities at Kansas University. They were shown a topographic map upon which were delineated the El Dorado Lake high water line and the government boundary. Each was asked about any personal knowledge of the area, for advice about published materials, and for names of other possible interviewees.

Geography

Since data collection and analysis have been concentrated almost exclusively upon the paleogeographic category, very little descriptive or definitive information can be recorded at this time in relation to the geography category. Only a few brief remarks will be made for now on each of its subfields. For short summaries, see Bradley (1973), Eoff and Johnson (1968), Fulmer (1976), Grosser (1970, 1977), and Leaf (1976a). The one by Fulmer contains by far the most information.

Physiography

Because physiography is so intimately related to both present and past geography, discussion will be included in the paleogeography section.

Climate

Information is available, and the greatest amount is contained in Flora (1948). A brief resume is in the Soil Survey of Butler County, Kansas (U.S.D.A. Soil Conservation Service 1975:56-58).

Soils

The Soil Survey of Butler County, Kansas (U.S.D.A. Soil Conservation Service 1975) appears to contain sufficient and adequate detail for conclusions about recent times.

Fauna

It would seem that the impact statement (U.S. Army Corps of Engineers 1972) would be the final word on species which currently occupy the project area. No other known source contains information related specifically to this area. There are many field guides, but they record each species no more specifically than by county. Mr. Joseph Collins has informed me (1978: personal communication) that it is unlikely that there has been any significant change in reptile and amphibian composition since white contact, and that the same can probably be said for all other animal types. The main differences seem to be in the current lack of such large mammals as bison and antelope which were eliminated from the area by white encroachment.

Flora

As with the fauna, the most definitive work available on the present flora is the impact statement (U.S. Army Corps of Engineers 1972). And again, there are field guides, but they do not pinpoint plant types any more closely than by county. As with the fauna, the impact study species' list can probably be extrapolated back to the time of white contact. Dr. A. W. Küchler, who is recognized as a world authority on plant geography, believes that no species changes have occurred, that the natural vegetation still exists in the area (1978: personal communication). He does believe, however, that the floodplain forest of pre-white contact times extended over the entire floodplain, and that it has been reduced by white agriculture. Dr. Küchler has produced a vegetation map for the state of Kansas along with a manual containing detailed listings of the various plant types that inhabit his designated zones (Küchler 1974). According to his scheme, the El Dorado Lake area contains but two major vegetation units. The uplands supported tall grass "bluestem prairie" and the valleys a "flood plain forest and savanna including

freshwater marsh." Dr. Ronald McGregor also believes that the species composition is "probably virtually unchanged", since white contact, "except in quantity" (1978: personal communication). To date, the Kansas Biological Survey has never made a survey of the biota of the El Dorado Lake area.

In concluding this discussion of the geography of the area, it might be of interest to include a few quotations from an 1887 source (Butler County, Kansas 1887), along with a warning that this is what might be called a "chamber of commerce publication" that urged new immigrants to come hither and settle in their bountiful land.

> ..it is one of the best watered counties in the State. By actual count there are twenty-three streams of water in the county, which never go dry. Along their banks are to be found walnut, elm, oak, hickory, hackberry, cottonwood and other varieties of natural timber (Butler County, Kansas 1887:11).
>
> Many fine springs are found in various portions of the county, some of them affording a volume of water sufficient to furnish water power for machinery. In no portion of the State are springs so abundant (Butler County, Kansas 1887:11-12).
>
> The Walnut river, ...is fed by springs, is a clear running stream with gravelly or stone bed and affords an abundance of black bass, channel cat, buffalo and other varieties of fish as do all the other streams in the county... All these streams are skirted with timber, possessing practically the same characteristics (Butler County, Kansas 1887:12).
>
> ...we have over twenty thousand acres of artificial forest growing on our prairies, which number is being largely added to each year. As nature failed to supply us with trees, we have concluded it our duty to supply the deficiency (Butler County, Kansas 1887:16).
>
> Every year the order goes out and is announced through the state, "Plant trees," "Plant trees," and how enthusiastically the command has been obeyed, let the thousands of groves and blooming orchards which now adorn our once treeless plains, testify. And so cheerfully has the earth responded to the touch of the wand of labor, that our early planters sit in the shade of their own trees or partake of the delicious fruit. What an effect this and other agencies have had upon our rainfall. The average rainfall for the ten years 1854-1863, was 23.41 inches; for the second ten years - 1864-1873, it had increased to 26.46 inches, giving an average increase of 3.05 inches per annum, while the record for the third decade shows a like increase. We are rapidly reaching a period in this country when the cultivation of trees will

> be as much a matter of business as the growing of corn... we are changing the sky itself, and are making it rain where it did not before, even up to the very foot of the Rocky Mountains (Butler County, Kansas 1887:16-17).

> Now there are thousands of acres of what was formeraly [sic] prairie that are completely sodded with blue grass...many farmers have a considerable acreage sodded to tame grasses (Butler County, Kansas 1887:23). (Note: "tame grasses" are introduced types.)

Paleogeography

Paleogeography covers a vast range of subjects, including paleogeomorphology, paleoclimatology, paleopedology, paleozoology, paleobotany, and paleoanthropology. Together these studies help model past earth history as related to the changing natural world. Man is viewed, as not only a part of the natural world, but also as an agent of its change through time. Thus, once man appears on the scene, his presence makes mandatory an orientation in which he and all aspects of the environment are collectively related as a large and complex integrated whole. Although, for analytic purposes, it is possible to separate out the subfields listed above, paleogeography ultimately must be considered in its entirety. The methods of research and the contexts for each subfield are similar in that all are related to geologic sediments, stratigraphic relationships, and geologic processes.

The following summary of pertinent information derived from all presently known published sources is presented as a guide for on-the-spot field studies. Sources used for this summation include: Bayne (1962); Butler County, Kansas (1887); Fath (1921); Frye (1955); Frye and Leonard (1959); Leonard (1972); and, Schoewe (1949). There is little information specific to the project area. Only Fath and Leonard contain any at all, and this is slight, and of limited value.

The El Dorado Lake project is located on the upper Walnut River and its tributaries just to the northeast of the city of El Dorado, Butler County, Kansas. Butler County is in south-central Kansas and is the largest county in the state. The planned reservoir will occupy a large portion of the western half of the northeastern quarter of the county. Elevations within the government boundaries range from about 1280-1400 feet above sea level. Physiographic classification places the area within the Interior Plains Major Division of the United States, within the Central Lowlands Province, within the Osage Plains Section, and finally, within the Flint Hills Upland Minor Division. Geologically speaking, the Flint Hills are a portion of a 50-70 mile wide, north-south trending belt in which the surface formations are primarily of Permian age with Pennsylvanian exposures along the eastern margin. These formations are composed of limestones, shales, chert, gypsum, rock salt, red siltstones, and red sandstones. Some of the shales are also red. The limestones, shales,

and chert make up the Flint Hills, also known as the Blue Stem grass area.

The Flint Hills are an erosional feature, the result of a period of attrition that began at least as long ago as the early Tertiary. They are a topographic unit about 20 miles wide that trends in a north-south direction entirely across the state, with a total relief of about 350 feet. Limits are defined by the outcrop of chert bearing Permian rocks. These rocks are a series of closely spaced cuestas, and they have a gentle but persistent westward dip. The western boundary is not distinct, as it belnds in with adjoining topography. However, there is a sharply defined eastern border where exists a prominent rocky escarpment several hundred feet high. This escarpment is highly dissected, has terraced rocky slopes, and, "...is probably the most rugged surface feature of Kansas..." (Schoewe 1949:286).

The Flint Hills were formerly called the "Kansas Mountains." The present name was derived from the abundance of chert (flint) found on its surface. Schoewe tells us that,

> Nearly all the limestones of the unit contain some flint and some of the beds are composed entirely of this siliceous material. Since the flint or chert is practically insoluable, it is very resistent to weathering and erosion and tends to accumulate as rocky fragments strewn over the surface... (Schoewe 1949:288).

It was noted many years ago (Mead 1901) that the aborigines of the area made use of this resource. Ancient chert quarries were already then known to exist on the summits of the Flint Hills.

The upper surface of the Flint Hills is a broad bench with gently rolling topography. Shallow soils, formed on an equally shallow sediment cover, support lush bluestem prairies. Many streams are deeply incised into bedrock, and their beds contain fragments of limestone and chert. The only stream that crosses the Flint Hills is the Kansas River, at the northern end. The northern part is not as high or as conspicuous as the southern portion, and this is partially due to glacial planation in the north. The higher southern elevations range to about 1500-1600 feet. The project area is roughly 100 miles south of the southernmost extent of continental glaciation, and it was not directly influenced by it. However, climatic influences undoubtedly were a factor due to areal cooling and increased precipitation during glacial times, this in turn being followed by subsequent warming and drying during non-glacial periods. The uplands also have, in places, a thin veneer (one foot or less) of late Pleistocene loess that was probably transported from glaciated regions in the north. The upland surface is known, as well, to be pitted with some sinkholes.

The project area is on the western slope of the Flint Hills, and the Walnut River and the west branch of the Walnut River are within the pronounced Walnut Syncline. The El Dorado Anticline is adjacent to the west, and the maximum vertical distance between the two is about 180 feet. The Walnut River is a tributary of the Arkansas

River, and it drains an area of about 2,000 square miles. It has a channel length of about 110 miles as opposed to a straight line distance of about 58 miles. The drainage basin forms a rough triangle about 75 miles long and 40 miles wide with its apex at the south end. It drains most of Butler County, the central part of Cowley County to the south, and small parts of six adjoining counties. By 1921 several cities along the Walnut River were forced to abandon the river as a source of municipal water supply due to pollution by nearby oil field activities.

In contrast to the 1887 statements (Butler County, Kansas 1887) that the Walnut was among 23 perennial streams in the county, Fath tells us that,

> The Walnut and Whitewater rivers are intermittent streams, flowing only during rainy periods. They both, however, have a considerable subsurface flow, especially the main Walnut river and in its west branch, in which the groundwater is sufficiently high to maintain large ponds of water in the deeper depressions throughout the year (Fath 1921:16).

Apparently there is a great deal of subsurface drainage, and little surface drainage, throughout the Flint Hills, outside of the stream valleys themselves. The regional dip towards the west also makes for rapid down-dip drainage in the shallow limestone aquifers towards the rivers. And, wide ranges in grain sizes in the terrace deposits makes for a similar wide range in porosity and permeability. Leonard (1972) believes that area groundwater aquifers are self contained units that are recharged locally. That is, local groundwater amounts are dependent on local precipitation, and recharge over distant aquifer systems is negligible. If this is true, it would refute Leaf's suggestion (Leaf 1976a:62) that the area could have been a refugium during areal dry periods. He based this idea on the belief that local groundwater ultimately was transported from the Rocky Mountains by large aquifers, and that, presumably, that mountain mass would have continued to get moisture at times when the lower plains areas did not.

The 1887 Butler County, Kansas publication told of many springs in the area - some with large volumes, and that the Walnut River was fed by springs. Fath also pointed out the abundance of springs when he said,

> The subsurface drainage is probably the source of the ponded water in the deeper depressions of Walnut river. It also is the factor controlling most of the large springs, of which there are several in the river valleys (Fath 1921:16).

Leonard provides additional remarks on springs and groundwater,

> Many springs in limestone issue from joints which appear to provide the major avenues of migration for shallow ground water (Leonard 1972:13).

Now let us take a look at the deposits in the Walnut River drainage system. Fath (1921) and Leonard (1972) provide the only information that can be said to pertain specifically to the project area, and what they provide is meager. It has already been noted that the bedrock of the area is Permian in age. Apparently all of the regolith mantling the uplands and filling the stream valleys is Quaternary in age. Fath says,

> Covering the broad valleys of Walnut and Whitewater rivers and their larger tributaries are accumulations of muds, gravels and sands of comparatively recent geological age, deposited during the period since the rivers cut to grade and while they have been broadening their valleys by lateral planation. The materials were derived from the higher valley reaches and were brought to their present location principally during flood periods (Fath 1921:61-62).

> The valley alluvium in the El Dorado region contains but little common quartz sand because of the meagerness of siliceous bed rocks in the drainage area from which sand could be derived. Stream action on the broken limestone fragments reduces the rock to pebbles and to sandlike particles, but these small grains are relatively unstable because of weathering and then relative lack of resistence to solution to the ground waters. Hence calcareous sands, as such, do not form large quantities of the valley alluvium. The coarser materials - that is, the gravels and rubble - are in large part limestone fragments. The clays of the alluvium consist principally of the transported clays and shales of the shale formations, and in part of the weathering products of the limestone (Fath 1921:62).

And in a much more recent discussion, Leonard makes these statements:

> The Permian rocks are overlain by unconsolidated sediment, principally of Pleistocene age, which forms upland terraces and valley fill as much as 100 feet thick in the broad stream valleys. Except in the headwaters, the major streams in the basin generally follow meanders entrenched in alluvial floodplain deposits. The average height of the banks is about 20 feet. Except during periods of high flow, the channels are a series of pools separated by riffles, and the resistent bedrock that causes the riffles commonly is exposed in one bank (Leonard 1972:10).

> Terrace deposits and alluvial fill along the stream channels are assigned to the Pleistocene and Holocene series (Leonard 1972:1).

> Sediments deposited by the Walnut River and its tributaries consist mainly of locally derived material including pebbles of limestone and chert (Leonard 1972:13).

Soils tend to be thick, heavy, and poorly drained in the river valleys, whereas they tend to be thin and variable in permeability in the uplands (Leonard 1972:12-13).

Some miscellaneous information on young deposits of the Flint Hills in general is in Frye and Leonard (1959). They mention that chert fragments found on the upland surface also extend into the regolith subsurface, and are a large part of the recent alluvium of the valleys. And chert colluvium is abundant as veneers on slopes of intermediate angle. These colluvial cherts have two sources. Some are residuals left by differential weathering, and they tend to be uniform and angular. Others were deposited in high terrace deposits of stream-laid chert gravels, and these tend to be weathered and rounded. These stream deposited chert gravels are on terrace surfaces a few to several hundred feet above present floodplains. In low and intermediate level terraces, they are commonly interbedded with sand and silt. In the high terraces, the sand and silt is less common, and these may have weathered to a red clay matrix for the chert gravels.

Much of the significance of these last few comments lies in the mention of the existence of terraces. Little knowledge of terraces exists for the project area, but there is emerging a belief that as many as three or four may be there. This belief is further enhanced by studies conducted along the lower half of the Walnut River in Cowley County (Bayne 1962). Although interest centers about the uppermost one quarter of the river system, the knowledge provided by studies of the lower portion can serve as a guide for predictions of what may be found and where to look for terraces in the project area. According to Bayne (1962), the lower half of the river has three terraces, and he assigns these to the latter three glacial stages of the Pleistocene, with some possible overlap with the second and third interglacials. The sequence of Quaternary deposits is presented as a series of quotations interspersed with supplemental "notes":

Kansan and Yarmouthian Stages

> Deposits of chert gravel occupy a high terrace position along the valley walls of Walnut River and Grouse Creek and are present locally along other streams draining the area of Permian exposures in north-central and eastern Cowley County. These deposits, which are probably Kansan and Yarmouthian in age, are generally thin and are not continuous (Bayne 1962:68).

(Note: these deposits are assigned to the Grand Island and Sappa formations.)

Illinoisan and Sangamonian Stages

> Chert gravel deposits in terrace position to other major streams, which drain north-central and eastern Cowley

County, indicate that these streams were deepening their channels during this period. These deposits were observed in only a few localities, and in only one area were they thick enough to map (Bayne 1962:69).

(Note: these deposits are assigned to the Crete and Loveland formations; they are about 80 feet below the Kansan terrace, and about 30 feet above the Wisconsinan terrace.)

Wisconsinan Stage

> Terrace deposits equivalent in age to the Wisconsinan terrace deposits in the Arkansas River Valley are present in all the major stream valleys that drain northern and eastern Cowley County...(Bayne 1962:71).
>
> These terrace deposits are composed of limestone, chert gravel, and sand, intermixed with different amounts of silt and clay. The deposits contain beds of silt, beds of gravel containing almost no silt, and much gravel interspersed with silt (Bayne 1962:72).
>
> The Wisconsinan terrace deposits are the most important source of ground water in the county (Bayne 1962:72).

(Note: the following quotation refers to eolian silt deposits assumed to be Wisconsinan in age; the contact between the two could not be definitely differentiated.)

> Deposits of Kansan and Yarmouthian age are overlain nearly everywhere by these silts, which may have a thickness of as much as 30 feet (Bayne 1962:73).

Recent Stage

> Recent alluvium occupies the valleys of all the major streams in Cowley County, but all streams except Arkansas River are deepening their channels over most of their courses and, consequently, alluvium is present only in the narrow, active channels of the streams. The deposits are thin and are not mapped separately...They are composed of silt, sand, chert, and limestone gravel,...(Bayne 1962:73).

(Note: the floodplain has been removed, or nearly so, in the tributaries to the Arkansas River; where it still exists, it is lithologically similar to the Wisconsinan terrace deposits, and it is difficult to differentiate - it has to be done by surface position and topographic expression.)

> The surface of the alluvium is rough and hummocky, and old meander scars are common, whereas the surface of the Wiscon-

sinan terrace is relatively flat and exhibits a more mature stage of development (Bayne 1962:74).

The sum of the pertinent published information on physiography and paleogeography has been presented above. There are a few unpublished sources, as well, and these are enumerated here.

Rogers (1977) has made a brief reconnaissance of the Walnut River Valley near the Snyder Site just northeast of El Dorado, and south of Winfield, in an effort to locate terraces. In each place he was able to detect both the floodplain and a first terrace, but no second terrace. At the Snyder Site the floodplain is about 15.5 feet and the first terrace about 20 feet above the river level, and south of Winfield the floodplain is almost 24 feet and the first terrace about 28.5 feet above river level. In each place the floodplain to first terrace distance is 4.5 feet.

Records of water wells can provide sedimentary and stratigraphic information. Mr. Howard O'Connor, Kansas Geological Survey, is serving as a newly created repository for these records. However, so far, his files contain only three records of upland wells in or near the project area, and about all that can be determined from them is that the regolith is a shallow 5-7 feet thick.

Mr. Jesse McNellis of the U.S.G.S., Lawrence office, has personal knowledge of the project area, which leads him to believe that high terraces exist along the Walnut River there (1978: personal communication).

Bradley (1973), Fulmer (1976, 1977), and Grosser (1970, 1977) present subsurface data, based on archeological site excavations, which is useful, but limited in pertinent value. These are restricted to rather shallow penetrations, and they have not been adequately defined or related to the overall stratigraphy of the area.

PROJECTED FUTURE RESEARCH

As an introductory statement, it should be noted that what is to be said below is subject to future modification due to unforeseen constraints of time, equipment, and funds.

Field Work at El Dorado Lake

As mentioned previously, paleogeographical investigations will be concentrated upon subsurface landforms, sediments, stratigraphy, paleosols, and fossil remains. Initial reconnaissance should provide a broad familiarity which will enable the determination of the future direction of research. Sediment exposures will be noted, and their horizontal and vertical extents will be mapped as part of a growing framework for more detailed stratigraphic studies. Rock outcrops will be considered as sources of mineral resources, and springs, depressions

and other features will be recorded. Indications of terraces will be a major concern. Data will be correlated with aerial photographs and topographic maps.

Complicating factors are anticipated, which include the masking of terraces and other deposits (by vegetation, slope wash, and crops) and accessibility to certain areas by both persons and equipment. Also, not many sediment exposures are expected to be found, and it is anticipated that much of the paleogeographic reconstruction will depend upon subsurface testing. A number of auger and drill holes and backhoe and/or bulldozer cuts will likely be necessary.

After the initial survey, later work will involve the detection, notation, and/or compilation of: sediment depths and types, stratigraphic relations and profiles, paleochannels, terrace relations and locations, unconformities, and archeological sites that pre-date those so far known in the project area. An established terrace sequence can provide an important basic "working stratigraphy", and further refinement can be obtained from the detection of datable unconformities. Such breaks in the sedimentation sequence point to periods in which old land surfaces existed, which could have served as occupation zones for man and other organisms. Thus, they have predictive value in the location of undiscovered archeological sites. Levels containing paleosols, terrestrial organisms, erosional evidence, or known sites, are some of the indicators of unconformities to be sought.

Other field work will involve the collection of: sediment samples (for mode and environment of deposition studies), radiocarbon dating materials, cores (for sediment and stratigraphic analyses, and depth to bedrock data), recorded core data from various local sources, and plant and animal fossils (for compiling a list of possible human food items and other resources, and for paleoecological studies). It is unlikely that plant macrofossils have been preserved in this moist environment, however, small fragments may be recovered by water flotation methods. Small faunal remains may also be found in the residues of water screened sediments. Although preliminary sampling produced no ancient pollen (see Chapter 6, this report), probably any information concerning vegetational history will come from pollen studies.

Laboratory Work

Work during academic years will include: continued library research and consultations with specialists, compilation of bedrock maps, sediment analyses, fossil identifications and analyses, dating collected materials, drafting maps and profiles, and the writing of results.

An early need will be to attempt to compile the contours of the bedrock surface of the valley beneath the unconsolidated sediments. This "depth to bedrock map" will constitute a framework of basic geologic knowledge which will enable better access for more detailed studies of sediments, stratigraphy, and buried archeological sites.

It will define vertical and horizontal limits for buried sites; that is, it will set predictive limits for site locations and their relative ages. A second map, a "bedrock surface configuration map", would also be useful in the overall paleogeographic reconstruction. It could indicate topography and drainage patterns prior to the establishment of the modern Walnut River and its deposits. Core data will be used in the construction of these maps.

Collected sediments will require extensive study. Washing, screening, and flotation methods for the recovery of small faunal and floral remains should be conducted with some samples. Others should be subjected to grain size analyses to help determine such things as environments of deposition, stream competence, stratigraphic breaks in the record, cycles of deposition, sources of sediments, shifts in channel position, etc.

HYPOTHESIS TESTING AND EXPERIMENTAL STUDIES

Although it is yet too early to present detailed hypotheses to be tested for the El Dorado Lake region, it is likely that many will be forthcoming as the data pile grows. One of these is the Ecological Resource Zone Model (of potential subsistence items) as proposed in the research design (Leaf 1976a:23-27). An attempt should be made to provide data to help determine the validity of this model, to see if it is adequate, too general, or too specific. Based on research thus far, indications are that Leaf's list of subsistence items is reasonable for the early white contact period. The area seems to have undergone little biotic change from that time to the present, except for the loss of large game mammals such as bison and antelope, which were eliminated by modern immigrants. But such a specific model would only be useful for a restricted time period, one which falls after all prehistoric occupation. It probably has little value in application to the 11,000-12,000 years of man's known existence in the New World, or even to the less than 5,000 years so far established in the project area. Only evidence forthcoming from field investigations can establish a long term model. Despite the recent situation, it is still necessary to obtain evidence from the whole range of deposits in order to say anything definite about past environments. Geologic studies, along with data from the archeological sites, will shed more light on the sequence of possible resource items, providing plant and animal remains are recovered.

Other postulations to which the El Dorado Lake research might add supportive evidence are these:

It is believed that a major reason why Early Man sites are almost unknown within the state of Kansas is that, to date, little organized effort has been directed towards looking for them. The fact that they do exist in every state adjoining Kansas makes it probable that they do exist in Kansas as well, and it is believed that they can be found if they are sought in appropriate deposits. However, at this time, it is unknown that these deposits exist in the Walnut River drainage.

Leaf (1976a) has suggested that cultural changes in the area might be related to environmental changes, or that they could be due to other factors such as invention, diffusion, invasion, changes in preference, etc. It is not certain that major cultural changes have actually been demonstrated yet, but if they are detected they should be weighed against the postulation that they were environmentally induced. A clue to food preferences may be found by comparing plant and animal remains found away from contemporaneous archeological sites with those found within the sites. This may be extremely difficult, however, because of the necessary precision required in establishing contemporaneity. Existence on the same old living surface would offer the best evidence.

<u>CHAPTER 6</u>

PRELIMINARY SURVEY FOR PALYNOLOGICAL SITES IN THE EL DORADO LAKE AREA, KANSAS

James E. King[1]

INTRODUCTION

In conjunction with the archeological research being conducted within the El Dorado Lake project, a preliminary survey was made to ascertain the potential for palynological studies in the area. There are no published pollen records from south-central Kansas and, to my knowledge, no one has surveyed within the region for possible sites. Although good radiocarbon dated palynological data are available from northeastern Kansas (Grüger 1973), Missouri (King 1973; King and Allen 1977), and Texas (Bryant 1969, 1977; Larson, Bryant and Patty 1972) on which to base expected shifts in the vegetation and climate, a locally derived pollen study is helpful in interpreting short term variations in the cultural record. Preliminary archeological surveys in the project had located two potential areas that might contain prehistoric pollen records. In July 1977, these areas and several others within the region were investigated.

FIELD SURVEY

The El Dorado Lake project in south-central Kansas occupies an area of gently rolling topography drained by the Walnut River. The native vegetation of the region is tall grass bluestem prairie dominated by bluestem (*Andropogon* spp.), switchgrass (*Panicum virgatum*) and Indian grass (*Sorghastrum nutans*); along the drainages and around local water sources are small stands of floodplain forest dominated by hackberry (*Celtis occidentalis*), cottonwoods (*Populus* spp.), willow (*Salix* spp.), and elm (*Ulmus americana*) (Küchler 1964, 1974). The soils in the region are primarily upland prairie soils and rather oxidized.

The two locations within the project that looked promising for palynological studies were a small spring fed marsh (near 14BU9) and several alluvial exposures along the banks of the Walnut

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River (Fig. 6.1). The spring fed marsh is located in a small drainageway with the spring issuing from exposed horizontally bedded rock at the upstream margin. The water flows out and across a basin approximately 50 m. long and 20 m. wide containing the marsh. The basin contains dark organic silts and supports a marsh community including species such as cattails (Typha spp.), sedges (Scirpus spp.), calamus (Acornus calamus), and arrowhead (Sagittaria spp.); calamus is introduced. During field inspection, however, it was apparent that the sides of the basin formed a low rim indicating that the spring had been dredged, probably in an attempt to make a pond for watering cattle. At the down stream end of the marsh were the remains of a breached earthen dam indicating that the modification may have been unsuccessful. Although we were disappointed to find the spring disturbed, we probed over the entire basin with a hand driven soil probe in an attempt to locate any organic spring sediments that may have survived the dredging operation. The dredged sediments in the rim around the marsh were organic and indicated that a large volume of marsh sediments had once been present. This suggests that a spring supported marsh had been in existence for a considerable period of time prior to the dredging.

Unfortunately, we were unable to locate any sediments that appeared to be in place. The stratigraphy within the basin generally consisted of approximately 40 cm. of loose water saturated organic silt overlying a hard dry compact clay. These compact clays were stratigraphically 2 to 2.5 m. below the surrounding land surface. This depth provides an indication of the volume of sediment that was removed. Although no areas of undisturbed sediment were located, several short cores of the organic silts that have been accumulating since dredging were collected for pollen analysis.

At several locations along the Walnut River, high vertical banks are exposed as erosional cuts through the alluvial terraces. These terraces were constructed during earlier episodes of alluviation by the river and represent sections of the Holocene environmental record. At each of these localities, the alluvial sediments were composed of reddish silts and resembled reworked loess-like deposits; they were oxidized and appeared to contain very little or no organic material. In my experience, sediments such as these have not yielded pollen in the Central Great Plains. However, to check once again, a series of pollen samples were collected from the bank of a small tributary stream to the Walnut River near 14BU82. This site looked favorable for pollen preservation as the reddish silts contained a number of small dark organic bands apparently representing brief periods when water had been ponded in the tributary depositing organic lenses. It was hoped that these bands might contain pollen; unfortunately they did not.

In addition to this locality, sediments from another tributary, near an archeological site (14BU25) were also sampled. Again, they

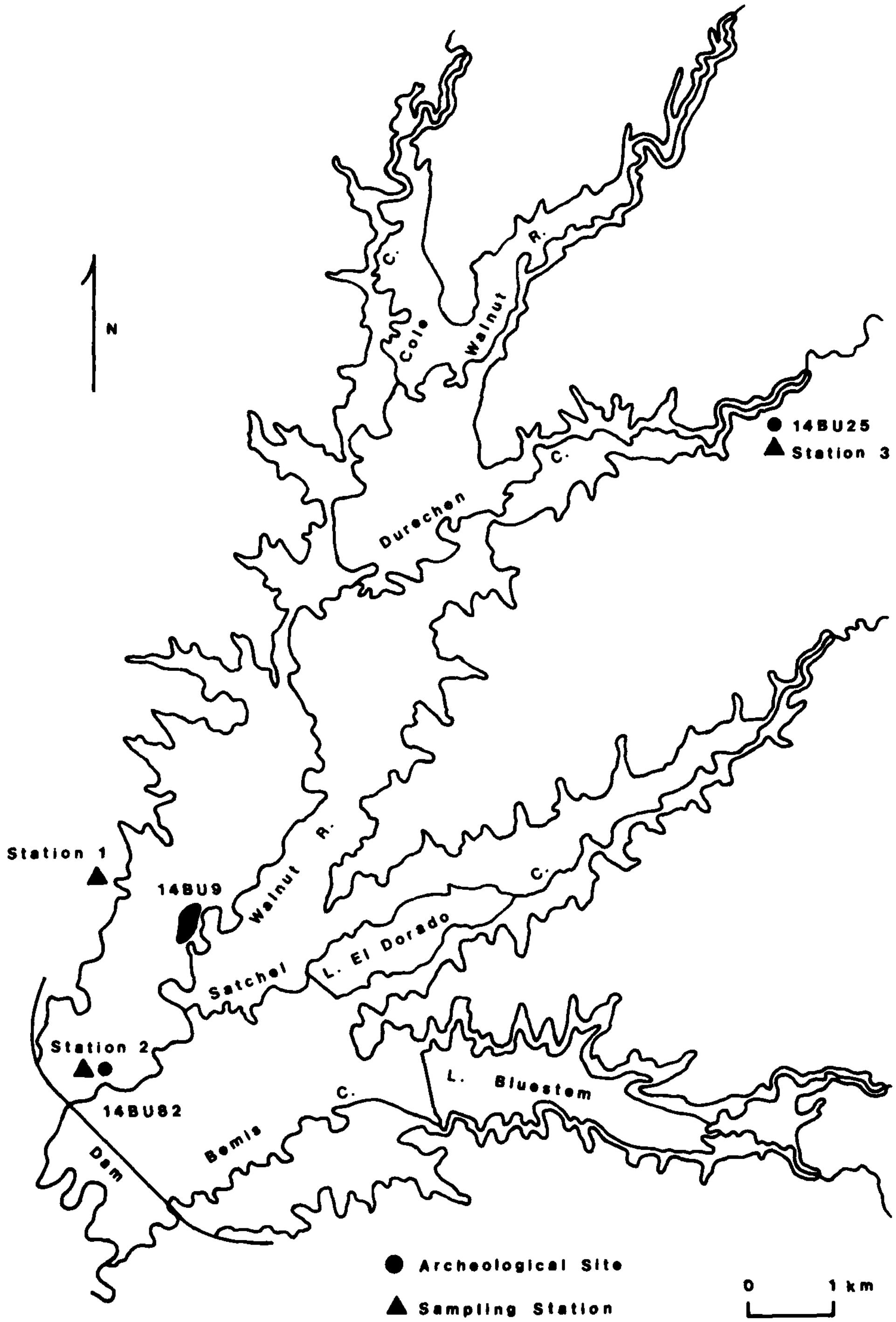

Figure 6.1. The location of soil sampling stations for the feasibility study of pollen extraction.

did not yield any pollen although the presence of small amounts of organic material suggests that the oxidation of these sediments had not been as intense as in the alluvial cuts along the river.

LABORATORY PROCEDURES

In the laboratory, all of the pollen samples were processed by procedures standardly used in palynology. After the samples were completely dispersed in water, the heavier sands and silts were removed by differential settling and then the remaining smaller sized silts and clays were removed from the sample by acid digestion; hydrochloric acid was used to remove the carbonates and hydrofluoric acid to remove the silicates. The residue was then acetolyzed for one minute, treated with 5% potassium hydroxide to remove any remaining humic acids, and then stained and mounted on slides for microscopic examination. For a good discussion of palynological procedures see Gray (1965) or Mehringer (1967).

DISCUSSION

As noted previously, none of the samples collected from the several localities in the El Dorado project yielded any pollen. The exceptions were the short cores of essentially modern sediments collected from the spring marsh near 14BU9. These silty sediments, about 40 cm. in depth, contained a uniform pollen flora dominated by grasses, herbs, and oak representing the modern flora of this area of Kansas. Although the marsh had been dredged and any prehistoric pollen record destroyed, the sediments that have accumulated since dredging contain pollen of the present vegetation and as such provide a reference for the pollen presently being produced by the local vegetation and deposited on the landscape.

Although sites suitable for the preservation of pollen records were not found in the El Dorado area during this preliminary survey, it should not deter further palynological exploration of the region. This is especially important in the search for special situations in which pollen might be preserved as has been demonstrated with copper artifacts (King, Klippel and Duffield 1975). Pollen preservation is capricious, especially in archeological sites, and the palynologist must make every effort to investigate all possible sources for preserved pollen. It is my recommendation that as further archeological investigations are conducted in this region, or any other area of Kansas, that palynological surveys be conducted simultaneously. The cost is very small compared to the potential payoff in paleoecological information.

AN OUTLINE OF LATE QUATERNARY VEGETATION CHANGE FOR SOUTH-CENTRAL KANSAS

The following outline of the vegetational changes that have occurred in south-central Kansas since the end of the Pleistocene is based on published palynological data by various workers from the Central Great Plains. All of these studies have good radiocarbon control. Although no sites suitable for the recovery of a long palynological sequence were found in Butler County, Kansas, there have been sufficient regional pollen studies to allow the construction of an "expected" paleoenvironmental chronology.

Vegetation changes throughout the Late Quaternary have generally been time-transgressive events in midcontinent North America occurring first in the south and west, then occurring at successively younger times to the north and east. This pattern of vegetation movement is related to the geography of deglaciation in eastern North America. With the onset of climatic warming, about 15,000 to 18,000 years ago (Bryson et al. 1969), the Laurentide ice sheet began retreating in a northeasterly direction allowing the climatic circulation patterns typical of the postglacial to be established from the south and west. As the final wasting of this vast ice mass did not occur until about 8,000 B.P., the atmospheric circulation systems took many thousands of years to reach their final and current position. This northward and eastward movement of air masses following the retreat of the ice is seen in the development of the early Holocene vegetation and the migration of species into the deglaciated northeast (Bernabo and Webb 1977). The transition from Pleistocene-age coniferous dominated vegetation to the deciduous forests and prairies of the postglacial occurred therefore over a period of many thousands of years but at any one location it occurred in about 1,000 years.

Several pollen studies from bogs in north and central Texas (Bryant 1969, 1977; Larson, Bryant and Patty 1972) show that spruce, indicative of Pleistocene environments, existed in northeastern Texas until about 11,000 radiocarbon years ago. Spruce did not occur in central Texas, but the lowest levels of a bog there did contain birch as well as high percentages of tree pollen. These Pleistocene pollen assemblages are interpreted as reflecting an oak parkland vegetation suggesting a cooler and more mesic environment. Annual precipitation may have been 254 to 508 mm. greater than the present. By 10,000 B.P. birch was gone from central Texas and spruce had disappeared from the state. The pollen from these zones reflects a general decline in trees indicating that the oak parkland had been replaced by an oak savannah grassland containing scattered trees. The floodplain forests also became less dense during the early Holocene transition to postglacial climate. After this transition, there are no further marked shifts in the vegetation implying that the Holocene vegetation and climate of central and northeastern Texas were relatively stable. The pollen data contain no readily

apparent evidence of an altithermal warm/dry period. Although it is not clearly evident in these Texas pollen diagrams, the grassland areas of this region were probably established during this early Holocene climatic change.

Pollen data from Muscotah Marsh, northeastern Kansas, (Grüger 1973) show spruce forest being replaced by deciduous forest with prairie elements sometime between 15,000 and 11,340 B.P.; unfortunately there is a hiatus in the pollen record at this critical point. However, late Pleistocene spruce forests are present in western Missouri until at least 13,500 B.P. (King 1973) and indicate that the transition from glacial to postglacial vegetation probably occurred about 12,000 B.P. in eastern Kansas. The existence of spruce in northeastern Texas for another 1,000 years is probably related to local edaphic features and the microclimate of the Texas bogs.

Unlike the Texas pollen records, the Muscotah Marsh pollen record contains the evidence of definite vegetation shifts within the postglacial. By 9,900 B.P. an increase in ragweed and a decrease in the percentage of tree pollen is interpreted as the beginning of the prairie period. This period of decreased tree pollen is interpreted as a change to a warmer/dryer climate and lasts at Muscotah Marsh until 5,100 B.P. when there is renewed development of oak-hickory woodland and a return to more mesic conditions. As prairie developed in an eastward direction in the central United States, later dates for its beginnings and earlier dates for its ending are seen to the east. At the Old Field, a large swamp in southeastern Missouri, prairie development is indicated by desiccation of the swamp and the drastic reduction of the swamp forest (King and Allen 1977). Dry conditions persist at the Old Field until about 6,000 B.P. Similar dates for prairie expansion are seen in pollen diagrams from bogs in northern and central Illinois (King, in press).

The El Dorado Lake area in south-central Kansas is presently dominated by bluestem prairie with floodplain forest along the Walnut River and its major tributaries. Interpreting its paleoenvironmental history from the regional pollen data, the prairies probably developed in the area about 10,000 years ago after a brief several thousand year interval of deciduous forest which replaced the spruce at the end of the Pleistocene. Once the prairie developed, it has persisted to the present with few changes. As Butler County presently supports very little forest, I would expect that the effects of any altithermal climatic fluctuations would have been minimal and primarily restricted to the floodplain forests. The climatic pressures on these floodplain communities would also have been compounded by altered stream flow regimes. Based on the chronology of the pollen evidence, I would expect that any altithermal effects on the vegetation would be expressed between approximately 10,000 B.P. and 5,000 B.P. Maximum warm/dry climatic conditions would have occurred between 8,000 and 7,000 years ago.

CHAPTER 7

CHARACTERIZATION OF THE CHERT RESOURCES OF EL DORADO PROJECT AREA

Chérie E. Haury

INTRODUCTION

In the research design for the El Dorado Project Leaf (1976a:62) posed a number of questions about the utilization of chert raw materials in the project area:

1) What are the kinds and sources of cherts utilized by the inhabitants of different components?
2) How was chert obtained?
3) What was its role (if any) in determining settlement patterns?
4) Are there variations in manufacture, use, wear, or disposal patterns based on different types of chert?

This report is the first step in a research program aimed at solving these problems. It is concerned with the initial questions which must be answered:

1) What are the sources of chert in the project area?
2) Is it possible to characterize these cherts in such a way that they can be consistently distinguished from each other and from cherts of nonlocal origin?

Since the success of Gordus *et al*. (1967) in discovering the sources of obsidian found in Illinois Hopewell sites using sodium and manganese neutron activation analysis, similar attempts have been made to use physico-chemical means to trace sources of chert artifacts. The primary forms of analysis experimented with, trace element analysis, X-ray fluorescence, and neutron activation analysis (Johnson 1977; DeBruin *et al*. 1972; Sieveking *et al*. 1970; Angino 1964; Aspinall and Feather 1972) met with only minimal success. This is because usable discriminations are dependent upon variation of trace element concentrations between specimens being less than that between formations (Johnson 1977:44). This situation exists in obsidian flows, which are highly homogeneous, and, as a result, fairly positive identifications can be made. Chert, however, is sedimentary material deposited over a long period of time and subject to the many chemical and physical changes of the depositional and diagenetic environment. As a result, cherts exhibit wide lateral and vertical variation both chemically and physically (Gordus *et al*. 1967:95).

The potential for physico-chemical characterization of chert has been tentatively established for types which are homogeneous, with few morphological complications (Aspinall and Feather 1972). However, not enough is understood about trace element distribution, depositional environments, and local post-diagenetic processes to allow these methods to be practical for most chert. To obtain the information necessary for comparative trace element analysis, an extensive sampling of chert formations and analysis by a geochemist would have to be undertaken. Sampling would have to cover the entire vertical and horizontal extent of each chert-bearing formation, a project which would require a great deal of time and expense.

Physico-chemical analyses may be unnecessarily complicated. It is proposed that combinations of attributes can be found which will distinguish various cherts without need for extensive geochemical analysis. This study is an exploration of the potential of descriptive techniques based on macroscopically observable features for characterizing chert. If cherts from two different outcrops are found to be indistinguishable on this basis, unless some other factor such as accessibility was involved, it is possible that the outcrops were not differentiated by prehistoric flint knappers.

The chert which is contained in the exposed stratigraphic sections of the southern Flint Hills was chosen to test the hypothesis discussed above. A circle with the town of El Dorado at its center and a 50 km. radius defines the extent of the research area.

Section one of this report, "The Geology and Chert Resources of the Area", constitutes a search of the geologic literature pertaining to the southeastern portion of Kansas. Although many of these geologic studies were done before the general acceptance of standard metric measurement, all measurements in this report have been converted to metric units.

THE GEOLOGY OF THE RESEARCH AREA

El Dorado Lake (Leaf, Chapter 1, this volume) is located in Butler County on the drainage of the Walnut River (Fig. 1.1, this volume). The Flint Hills are the prominent geologic feature of this portion of Kansas. They are a product of the differential weathering of soft limestone and shale beds and the much more resistant chert which occurs abundantly throughout the region. This resulted in the formation of broad, flat-topped hills capped by the resistant chert beds and bordered by steep slopes composed of the softer beds. The upland surfaces slope gradually toward the west as a result of the tendency of the stratigraphic layers to dip in that direction. To the east they present a steep, stepped escarpment 60 m. or more high.

Figure 7.1 is a portion of the U.S.G.S. map of the exposed rocks in southeastern Kansas. Within the designated 50 km. area three geologic stages are exposed. The Gearyan Stage (formerly

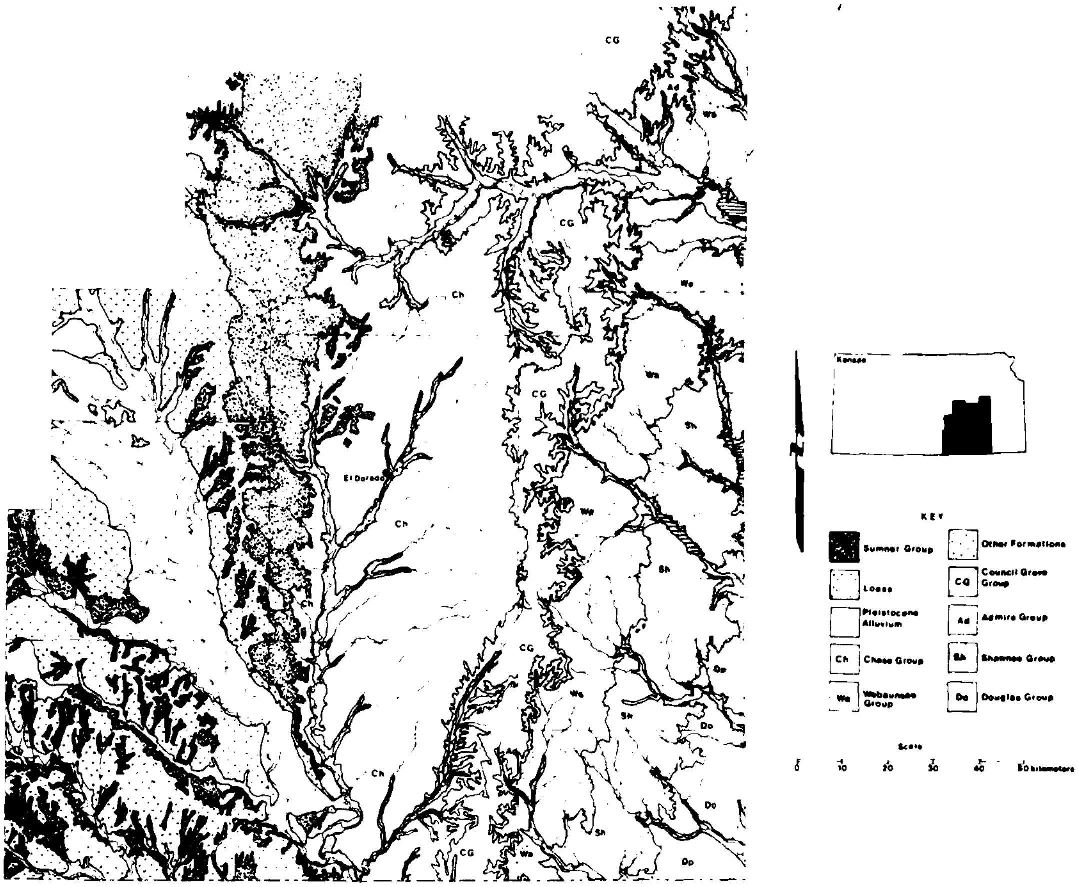

Figure 7.1. A portion of the U.S.G.S. Geologic Map of Kansas (1964) illustrating the kind and location of exposed rock units in the research area.

Wolfcampian) is the primary unit. It is exposed in a belt which runs in a north-south direction through all but the extreme western portion of Butler and Cowley Counties, all of Chase County, the eastern third of Marion County and the western edges of Elk, Greenwood, and Lyon Counties. To the east, also trending in a north-south direction, is the older Virgilian Stage of the Pennsylvanian System. The rocks of this unit are exposed in Chautauqua County, the eastern portions of Sumner and Sedgwick Counties, and the western regions of Marion and Dickinson Counties. Alluvium of Quaternary age is found along the Arkansas and Walnut Rivers and their tributaries as well as the Cottonwood, Elk, and Fall Rivers.

The Gearyan Stage is the lowermost stage of the Lower Permian Series, Permian System. Predominantly limestone and shale units totaling approximately 240 m. thick (Fig. 7.2), it is comprised of, from oldest to youngest, the Admire Group, the Council Grove Group, and the Chase Group. Members of this stage are the principal chert-bearing units in the research area.

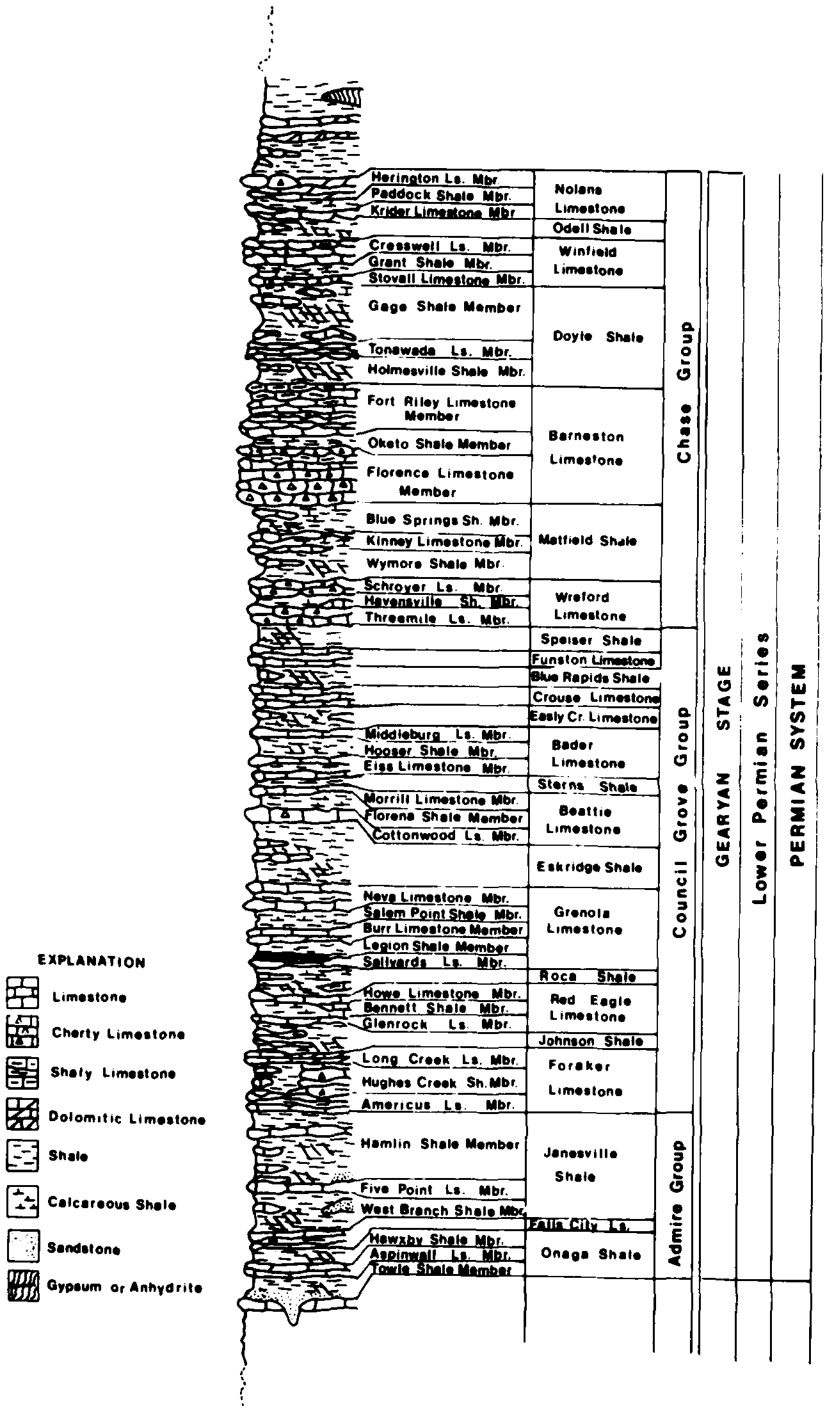

Figure 7.2. Stratigraphic section of the Gearyan Stage showing the relationship of the chert-bearing members to the rest of the series (Zeller 1968, Plate 1).

The Admire Group is about 40 m. thick. It is subdivided into the Onaga shale, Falls City limestone, and the Janesville shale. None of the members of these units are reported to contain significant amounts of chert (Moore et al. 1944, 1951a; Zeller 1968).

Above this is the Council Grove Group which is made up of 94 to 101 m. of limestone and shale. At the bottom of this group is the Foraker limestone which averages 15 m. in thickness and forms a rock ledge capping the steep slope of the Admire shale. These slopes and ridges project eastward from the rim of the Flint Hills creating a prominent outcrop which identifies the formation nearly everywhere in Kansas (Bass 1929:47). The Foraker is comprised of two limestone and one shale unit. The limestone units, the Americus and the Hughes Creek shale, both contain quantities of chert.

The Cottonwood member of the Beattie limestone is the next chert-bearing unit of the Council Grove Group (Zeller 1968:47; Moore et al. 1951a:13; Banks n.d.:24). In southern Kansas this normally massive limestone tends to become thin and shaly. From Chase and Lyon Counties southward it is exposed low in the eastward-facing slopes of the Flint Hills. It rarely crops out as a ledge, rather it forms a shoulder or terrace slope marked by a fringe of shrubs along much of the outcrop (Bass 1929:59; Zeller 1968:47).

The third group of the Gearyan Stage, the Chase Group, is made up of 102 m. of escarpment-forming limestones alternating with layers of shale (Zeller 1968:48). The conspicuous ledges created by this formation can be seen in eastern Butler County and in many locations in Chase and Cowley Counties. The bottom unit of the Chase Group is the Wreford limestone. This unit ranges in thickness from 9 to 12 m. It is characterized by the abundance of chert found in its two limestone members, the Threemile limestone and the Schroyer limestone (Zeller 1968:48; Moore et al. 1951a:44; Bass 1929:67; Hattin 1957:63).

Further up in the Chase Group is another important chert-bearing formation, the Florence limestone member of the Barneston limestone. The Florence limestone also exerts a marked influence on the topographic features of the area. It forms a broad upland surface which is inclined westward at a low angle. Where chert is not noticeable on the surface of the ground, shallow digging will usually expose it (Fath 1921:47-48; Bass 1929:79). This upland surface is especially prominent in Butler County where the unit reaches its maximum thickness. There are also many exposures of the Florence member along the Walnut River and its tributary creeks. Some may well reach 11 m. in thickness (Fath 1921:47). The formation thins southward in Cowley County and the percentage of chert decreases (Bass 1929:78). It is important to note that Bass (1929:79) reports numerous natural springs along outcrops of the Florence limestone.

The Winfield formation of the Chase Group is represented in the El Dorado area by a single heavy-bedded limestone. Further south it becomes inter-bedded with shale (Fath 1921:59). It is

extensively exposed in Cowley County as a distinct escarpment along the edge of the Walnut River bottoms (Bass 1929:91). The Cresswell and Stovall members of this formation contain a large quantity of chert.

At the top of the Chase Group is the Nolans limestone. In northern and central Kansas it consists of one shale member separating two limestone members. However, in southern Kansas the boundaries are no longer clearly distinguishable (Zeller 1968:49). The Herington limestone member is dolomitic in this part of the state and contains concretions of chert and quartz. The dolomite is soft and weathers easily leaving the limestone exposed as a ledge (Bass 1929:97).

The exposed rocks of the Upper Pennsylvanian Series, the Virgilian Stage, are found to the east of Butler County. In Kansas the Virgilian Stage is represented by three groups, the Douglas Group, the Shawnee Group, and the Wabaunsee Group. It can be 366 m. thick (Zeller 1968:34). It contains but a few chert-bearing members, all in the Shawnee Group (Fig. 7.3).

The Plattsmouth limestone member of the Oread limestone contains chert in locally abundant quantities in northern Kansas, but it is not common in southern portions of the state (Zeller 1968:34; Moore _et al_. 1944:181). The Ervine Creek limestone member of the Deer Creek limestone is the next Pennsylvanian chert unit. This limestone contains chert in nodules in scattered locales (Zeller 1968:38; Moore _et al_. 1944:179). No other information concerning the distribution of chert in this formation is presently available.

A third member of the Shawnee Group, the Curzon member of the Topeka limestone, contains chert. It is readily identifiable in northeastern Kansas, but is not differentiated or is doubtfully identified in the southeast (Zeller 1968:38). Chert has only been reported as common where the unit is distinct (Moore _et al_. 1944:178).

The Cimarronian Stage which is exposed in the western portion of the research area is the uppermost stage of the Lower Permian Series. It is composed primarily of evaporite-bearing clastic rocks, that is, sandstone, siltstone, shale, anhydrite, gypsum, and salt (Fig. 7.4). None of these rocks contain chert (Moore et al. 1951a:38, 1944:157; Zeller 1968:50).

In addition to the local stratigraphic units, chert also occurs in the alluvial gravels found along the rivers and streams in the area. There are thin, high level chert gravel deposits in north-central and eastern Cowley County, in Butler County north of El Dorado and to the south near Leon (Honderich 1970:25; Bass 1929:106; Fath 1921:61-62). These deposits are associated with the Walnut River and its tributaries in Butler County; in Chase County they are along the South Fork and Cottonwood Rivers. Much of the chert in these gravels is in large cobbles. These cobbles have generally retained their original form modified only by rounded edges and corners. Though their origin is debatable (Honderich 1970);

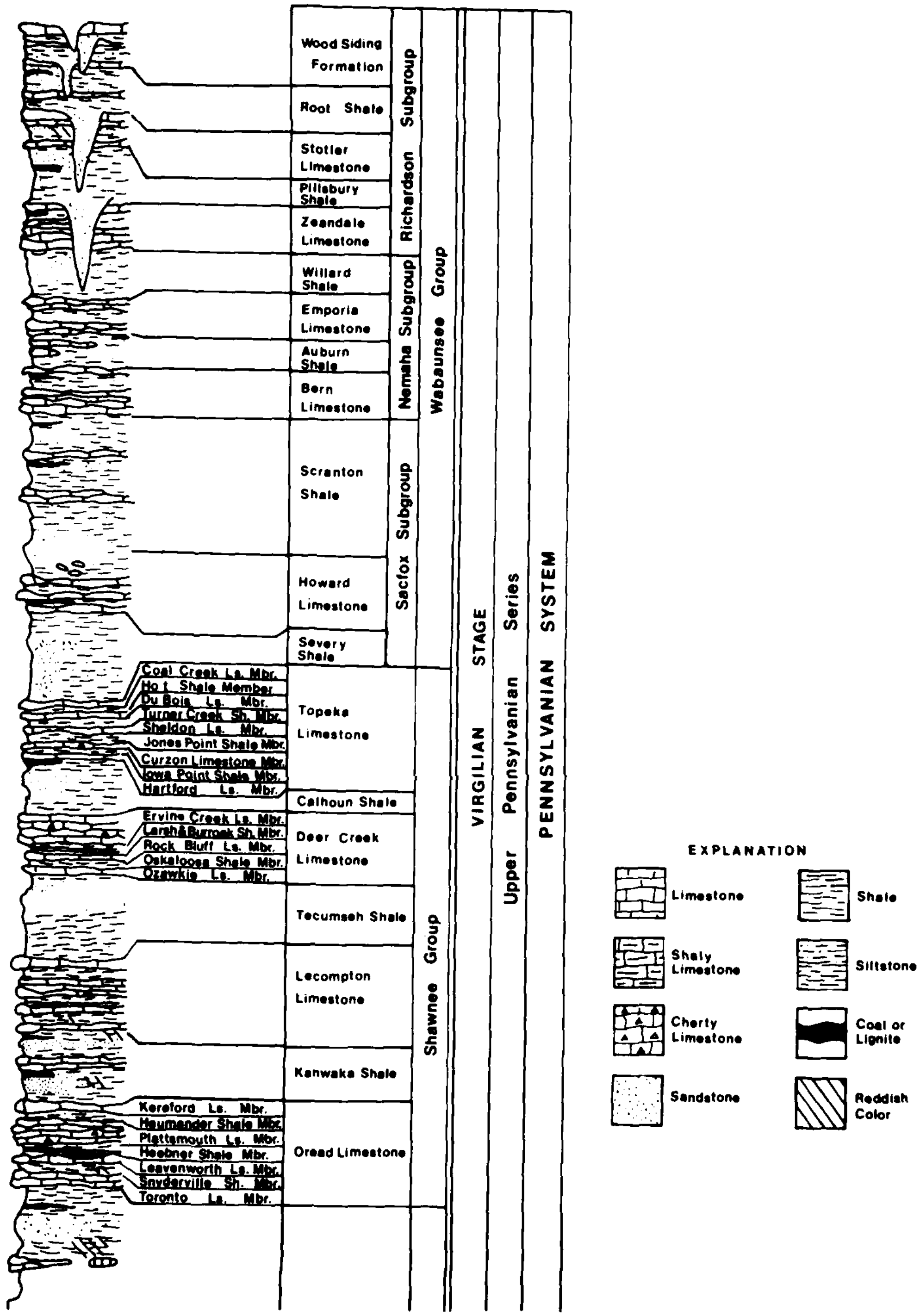

Figure 7.3. Stratigraphic section of the Virgilian Stage showing the relationships of the chert-bearing limestone units and other members of the formation (Zeller 1968, Plate 1).

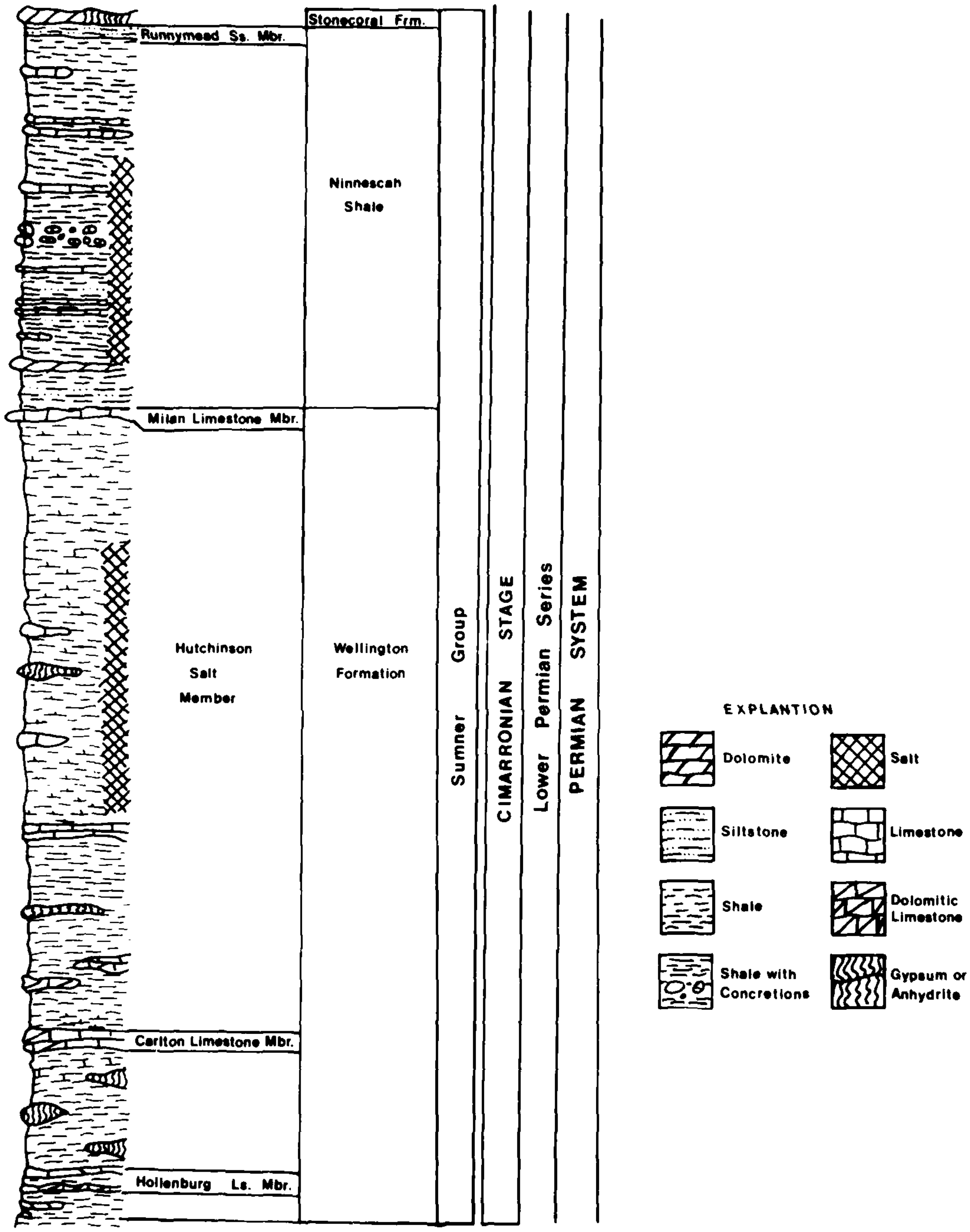

Figure 7.4. Stratigraphic section of the Cimarronian Stage exposed in the western portion of the research area (Zeller 1968, Plate 1).

Bass 1929:106) it is thought that they do not represent chert transported and redeposited from other formations.

To summarize, there are ten primary stratigraphic members which contain chert exposed within 50 km. of El Dorado. They are, from oldest to youngest:

1) The Ervine Creek limestone member of the Deer Creek limestone, Upper Pennsylvanian Series.
2) The Americus limestone member of the Foraker limestone, Lower Permian Series.
3) The Hughes Creek shale member of the Foraker limestone, Lower Permian Series.
4) The Cottonwood limestone member of the Beattie limestone, Lower Permian Series.
5) The Threemile limestone member of the Wreford limestone, Lower Permian Series.
6) The Schroyer limestone member of the Wreford limestone, Lower Permian Series.
7) The Florence limestone member of the Barneston limestone, Lower Permian Series.
8) The Stovall limestone member of the Winfield limestone, Lower Permian Series.
9) The Cresswell limestone member of the Winfield limestone, Lower Permian Series.
10) The Herington limestone member of the Nolans limestone, Lower Permian Series.

The predominant chert-bearing members occur in the Council Grove and Chase Groups of the Gearyan Stage. They are exposed in the immediate area of the El Dorado Lake Project and in the eastern slopes of the Flint Hills.

The chert in the Foraker, Wreford, Cottonwood, Herington, Deer Creek, and Winfield limestones is responsible for the resistence of these units to weathering. As a result, each unit exerts a strong influence on the topographic features of the region in the form of escarpments, ledges, shoulders, and shrub rows. The Florence limestone forms the upland surface in much of the area and is associated with many natural springs. The prehistoric occupants of the area were probably aware of the direct correlations of physical features with particular chert types. With this knowledge each of these cherts could easily have been located and obtained through visits to the outcrops or shallow digging in the uplands.

MACROSCOPIC CHARACTERISTICS OF LOCAL CHERTS

At the present time the only descriptive information available on the chert contained in the formations discussed above comes from the geologic literature. These references are not

concerned with chert in isolated form but rather as a feature of limestone. As a result, the amount of descriptive detail incorporated by each geologist is dependent on his own particular purposes and may vary widely from one publication to another.

In the Ervine Creek limestone chert occurs as nodules scattered in local clusters throughout the formation. No further descriptions are presently available (Moore et al. 1951a:188; Zeller 1968:38).

The chert in the Hughes Creek shale contains large fusulinids (Triticites and/or Fusulina longissima). These fossils are considered to be diagnostic of both the chert and the limestone of this formation. The chert is described as light tan or blue, weathering to light tan (Bass 1929:47).

Although Moore et al. (1951b:13) report chert from the Cottonwood member of the Beattie limestone as, "sparce to abundant in the drainage area of the Verdigris River, in southern Chase County", Banks (n.d.:24) was unable to locate and examine any of the nodules. Zeller (1968:47) describes this unit as thin and shaly in southern Kansas, this may account for the lack of chert in the area.

The Threemile and Schroyer limestones combine to make the Wreford one of the principal chert sources in the southern Flint Hills. Two types of chert are known from these formations; both have been studied macroscopically and petrographically by D. A. Hattin (1957). The most common type is compact to slightly porous, non-calcareous, nodular to bedded and fossiliferous. It is abundant in every Kansas exposure of either member. The color ranges from very light grayish yellow to almost black, and mottling is observed in many specimens. Weathering produces light colored patination. Fossils within the chert are almost invariably silicified. Large fossils are generally concentrated at the border and tiny fragments are scattered within the chert. Bryozoan, echinoderm, and brachiopod remains have been identified. Numerous rod like structures can be seen in many samples. Almost all of the chert exhibits a homogeneous interior without evidence of stratification or orientation of structures. Shrinkage cracks are almost entirely absent (Hattin 1957:80). From petrographic analysis Hattin (1957:80) describes a matrix of minutely crystalline chalcedony containing fossils and circular areas of radially arranged fibrous chalcedony. Nodules are gradational with the limestone matrix.

The second type of chert which occurs in these limestones is calcareous, brownish gray to dark blue, gray to dark gray, and sparcely fossiliferous. It is concentrically layered with broad bands dominantly of granular calcite. Light-colored bands grade outward to darker ones which contrast sharply with the next light one. The light colored portions of the bands contain abundant fossil fragments, some unreplaced, others replaced by fibrous chalcedony or internally filled with crystalline quartz (Hattin

1957:81). This chert occurs in continuous and nodular beds and is found in all outcrops of the Threemile limestone. It is also abundant in the Schroyer member in northern Kansas, except in central and southern Kansas, where it is replaced by the non-calcareous form.

The Florence member of the Barneston limestone is the dominant chert-producing unit in the immediate El Dorado area (Fath 1921:47). The lower section of the Florence limestone is characterized by abundant quantities of chert interbedded with the layers of limestone. The chert is distinctly nodular, although in some layers the nodules are commonly joined so that the layer is continuous (Bass 1929:78). Banks (n.d.:25) has noted that fractures typically result in rectangular blocks. Florence chert has been described by many geologists, Bass (1929:77), Moore et al. (1951a:45), Zeller (1968:48), Fath (1921:47), and Banks (n.d.:25). A summary of these descriptions characterizes the chert as steel-gray or blue-gray on freshly broken surfaces. Slightly weathered surfaces are tan becoming dark tan or rusty brown with further weathering. Highly fragmented fossils are exhibited in abundance, sometimes in relief. All fossils are recrystallized with silica.

The Stovall limestone contains an abundance of gray chert in northeastern Kansas where the formation is thin (Moore et al. 1951a:44; Zeller 1968:49). The unit thickens and becomes less cherty in Chase County, then becomes thinner again to the south, disappearing completely in Cowley County. Fossils are rare in this formation.

The Cresswell chert is predominantly nodular, commonly a light-gray varigated with veins of thinly banded cream or white chert of purer form than the gray material. Banks (n.d.:25) asserts that thin banding and waxy luster distinguish this chert from all others in the Flint Hills.

The uppermost stratigraphic rock unit which contains chert is the Herington limestone member of the Nolans limestone. The Herington is highly dolomitic limestone characterized by siliceous and calcareous geodes and concretions, and cauliflower-like masses of chert and quartz (Zeller 1968:50; Bass 1929:97). Bass reports this chert as white, drusy nodules commonly 5 to 8 centimeters in diameter exhibiting crenulated surfaces. They occur in outcrops of the upper part of the formation.

The chert cobbles which occur in the alluvial gravel deposits are subangular, worn, and patinated tan to reddish-brown in color. In addition some may be drusy. No size range has yet been delineated. Bass (1929:107) states that fossils occurring commonly in the gravels are similar to those in the Florence and Wreford limestones.

CHARACTERIZATION

It is obvious from the descriptive data summarized in Table 7.1 that inconsistent and subjective description is a serious deterrent to identifying the sources of chert found in archeological sites. Most descriptions of chert found in the archeological literature are neither sufficiently explicit nor comprehensive to be accepted as replicable criteria for sorting chert types. This is true even for the most commonly described cherts such as Alibates chert from Texas (Shaeffer 1958). The problem is more acute in the southern Flint Hills area because so little work of this type has been attempted. Only one chert characterization project is known to have been undertaken in the southern Flint Hills (Banks n.d.).

The same problems exist in the geologic literature. Since chert is usually treated as a feature of the limestone with which it co-occurs, often only presence or absence is noted. When more detailed discussion is presented the same information is not included for each chert type. It cannot be assumed that if a feature is not mentioned in a description that it is absent, only that it was not pertinent to the author. That characteristic then becomes useless as a comparative feature. Another problem is subjective adjectives. Color terminology is a prominent example of this. Without standardization, such terms as steel-gray, blue-gray, light bluish-gray, and dark bluish-gray are ambiguous and the potential of color as a key descriptive characteristic is destroyed. Third, most descriptions do not take into consideration the wide range of variation which exists in every formation. Before descriptive characterization can be an effective way to identify chert from archeological sites these problems must be dealt with.

Geologic studies indicate that a number of processes may be responsible for the inclusion of chert in sediments. These modes of genesis are reflected in the visible structure of the chert. If the means and conditions under which chert forms are sufficiently varied, then chert from different lithologic units will exhibit definitive combinations of diagnostic structures. It is suggested here that these features, along with characteristics of weathering can be used to distinguish chert formations.

It is posited in this paper that macroscopic characteristics can be used to distinguish chert types. This suggestion warrants examination of those features of genesis which may be good discriminating characteristics. These characteristics must exhibit variability from one formation to the next and they must be carefully described and defined. Each definition should account for the range of feature variation, they must be consistently applied to each type of chert studied, and they must be replicable.

Chert is found in limestone as tabular beds, lenses, or nodules. It is speculated (Krauskopf 1959; Twenhofel 1919; Pittman 1959) that these features are formed by either indirect precipita-

Table 7.1. Summary of local chert types as described in the geological literature.

ERVINE CREEK MEMBER * DEER CREEK LIMESTONE

Color:	Unknown
Patina:	Unknown
Surface:	Unknown
Fossils:	Unknown
Mode of Occurrence:	Nodules
Comments:	None

HUGHES CREEK SHALE MEMBER * FORAKER LIMESTONE

Color:	Light blue or tan
Patina:	Light tan
Surface:	Unknown
Fossils:	Fusulinids - *Triticites* and/or *Fusulina longissma*
Mode of Occurrence:	Unknown
Comments:	The fossil forms found in this chert are considered very characteristic of this formation.

COTTONWOOD MEMBER * BEATTIE LIMESTONE

Color:	Unknown
Patina:	Unknown
Surface:	Unknown
Fossils:	Unknown
Mode of Occurrence:	Unknown
Comments:	Moore *et al*. (1951b:13) report the chert as "sparse to abundant in the drainage of the Verdigris River, in southern Chase County."

Table 7.1. (continued)

THREEMILE MEMBER * WREFORD LIMESTONE

A. Noncalcareous Chert

Color:	Light grayish yellow to almost black
Patina:	Light colored
Surface:	Mottled
Fossils:	Highly fragmented, invariably silicified, randomly oriented, large fossils generally concentrated at the borders. Fragments of Bryozoa, Echinoderms, and Brachiopods have been identified.
Mode of Occurrence:	Nodules, gradational with limestone.
Comments:	Contains circular areas of radially arranged fibrous chalcedony.

B. Calcareous Chert

Color:	Brownish gray to dark bluish gray or dark gray
Patina:	Unknown
Surface:	Banded with light colored bands, dominantly finely granular calcite, some cryptocrystalline chalcedony and finely granular calcite. Light bands grade outward to darker ones which contrast sharply with the next light band.
Fossils:	Sparcely fossiliferous
Mode of Occurrence:	Continuous or nodular beds
Comments:	Light colored bands contain abundant fossil fragments, some unreplaced, others replaced by fibrous chalcedony or internally filled with cryptocrystalline quartz.

SCHROYER MEMBER * WREFORD LIMESTONE

Contains A and B above in northern Kansas. The Calcareous chert (B) becomes less abundant toward the south.

Table 7.1. (continued)

FLORENCE MEMBER * BARNESTON LIMESTONE	
Color:	Steel gray or blue-gray
Patina:	Slightly weathered - tan Heavily weathered - rusty brown
Surface:	Homogeneous
Fossils:	Abundant, highly fragmented, recrystallized fossils. May stand out in relief.
Mode of Occurrence:	Nodular. Nodules may be connected in continuous layers.
Comments:	Fractures typically result in rectangular blocks. Springs are numerous along outcrops of this formation.
STOVALL MEMBER * WINFIELD LIMESTONE	
Color:	Gray
Patina:	Unknown
Surface:	Unknown
Fossils:	Unknown
Mode of Occurrence:	Unknown
Comments:	Chert is abundant in this formation in northern Kansas but as the formation thins to the south it becomes less cherty. The formation is absent in Cowley County.
CRESSWELL MEMBER * WINFIELD LIMESTONE	
Color:	Light blue-gray
Patina:	Unknown
Surface:	Thinly banded with cream or white chert of purer form than the gray material.
Fossils:	Unknown
Mode of Occurrence:	Predominantly nodular.

Table 7.1. (continued)

Cresswell Member - continued	
Comments:	Waxy to vitreous luster and fine bands are reported to distinguish this chert from all others in the Flint Hills.
HERINGTON MEMBER * NOLANS LIMESTONE	
Color:	White
Patina:	Unknown
Surface:	Nodule surfaces crenulated imparting a "cauliflower-like" appearance. Nodules are drusy.
Fossils:	Unknown
Mode of Occurrence:	Nodules, commonly 5 to 8 cm. in diameter.
Comments:	Nodules occur in outcrops or are strewn on the surface formed by the formation.
ALLUVIAL GRAVELS	
Color:	Unknown
Patina:	Tan to reddish-brown
Surface:	Subangular, worn, heavily weathered
Fossils:	Similar to those found in the Florence and Wreford limestones.
Mode of Occurrence:	Large gravel deposits and scattered alluvium along the rivers and creeks.
Comments:	Cobbles are rounded and heavily weathered and may be drusy. No size range has been delineated.

tion, direct precipitation, or replacement. Further, these processes can take place before, during, or after diagenesis.

According to Krauskopf (1959:16), direct precipitation of gelatinous silica by water can take place only where abnormally high concentrations of silica are in supply. Such solutions may

come from such sources as hot springs or decomposition of hot volcanic ash or lava by a reaction with sea water. He suggests that this process may result in lenticular chert deposits. A characteristic of chert formed in this manner would be the presence of spilites and pillow lavas.

Pittman (1959:127) submits that local changes in pH can cause silica carried in solution to precipitate in the form of irregular masses. These masses may be deposited in burrows or crevasses in the ocean floor or remain free on the bottom until buried in accumulating sediments. This process would form nodules or flattened lenses which would contain unreplaced fossils and may be banded.

Twenhofel (1919:422) and Bissell (1959:178) have suggested that chert beds represent varying bottom conditions. If burial of sediment excludes oxygen, concomitant with physico-chemical conditions leading to the development of negative Eh potential, then the siliceous sediments would be affected. Precipitation of silica would be favored by decreasing pH. Conditions in the waters which would change the delicate pH and Eh potentials could account for primary or early diagenetic rhythmic banding of chert beds or nodules. Massive rhythmic features in chert beds may reflect seasonal changes (Twenhofel 1919:426).

Indirect precipitation is the process of solution and deposition of the opaline silica of marine organisms (Krauskopf 1959:16). As remains of these organisms accumulate, interstitial waters would become saturated with opaline skeletons. Changing pH or other physico-chemical factors would cause the solution or precipitation of this silica (Pittman 1959:132; Bissell 1959:178). Solution would take place preferentially at points along the thin edges of skeletons while deposition would take place on the flatter surfaces. As a result, a loose mass of organic remains would be consolidated into a hard silica mass. Krauskopf suggests that these cherts would be conspicuous in the abundant, recrystallized fossil fragments which they would contain.

Chert can also form post-diagenetically through the process of replacement (Twenhofel 1919:426; Pittman 1959:127). Replacement can take place during diagenesis. In this process silica in solution is carried through the sediments by diffusion. It is precipitated about nuclei of small pieces of silica or fragments of organic matter. The nodule would exercise an attraction for more dissolved silica resulting in further growth. The limestone-chert boundary is maintained by pressure exerted by the growing nodule on the associated lime sediment. Replacement can also take place post-diagenetically as siliceous minerals are deposited in solution cavities within a limestone matrix. Fossils would be mineralized but otherwise preserved as they were (Pittman 1959:127; Krauskopf 1959:17).

Color can be used to characterize chert. The color of chert is determined by grain size, texture, and kinds and number of impurities present (Hurst and Kelly 1961:251). Grain size and tex-

ture largely determine how much of the incident light that enters a specimen passes through or is reflected back at the grain intersurfaces. According to Hurst and Kelly (1961) this determined the value (according to the Munsell color system) of the chert's color. The kinds of impurities present in the rock affect its hue by controlling which wavelengths are absorbed. The amount of each impurity affects the degree of saturation of the color or its chroma, as well as its value.

Texture is a factor of the size and shape of the individual crystallites making up the formation, the nature of fossil inclusions or the outlines of fossil inclusions, and the form and distribution of mineral inclusions. For example, Hurst and Kelly (1961:251) relate that carbonates typically occur as unevenly distributed rhombs which impart a mottled appearance to the chert. The surface may assume a dusty or hazy complexion when clay impurities are unevenly distributed through the matrix. Banding is a primary feature interpreted as sets of growth lines which form as a result of changing conditions during direct precipitation or during the process of replacement.

Different patinas form on chert depending on their microstructure, the kinds of impurities present, their permeability, and the nature of the post-depositional environment (Hurst and Kelly 1956, 1961). Patination, then is another variable to be considered when characterizing chert types.

The features discussed above vary between stratigraphic units depending on the mode of genesis and variations in the post-diagenetic environment. Consistent use of all of these features in chert descriptions, employing Ireland's (1947) standard terminology for insoluable residues, and color terminology from the standard Munsell Color Charts should remedy many of the problems of establishing comparable chert types. Such rigorous characterization of chert is a necessary step which will facilitate study of the utilization of this raw material.

IMPLICATIONS FOR FURTHER RESEARCH

To understand the synchronic and diachronic relationships of chert selection, procurement, and utilization, or its relationships to settlement and subsistence in prehistory, it is necessary to have a thorough working knowledge of the nature of the locally-available chert resources. A replicable method of characterizing these cherts apart from their stratigraphic context is imperative. It has been proposed that characterization based on description is sufficient for this purpose if it is standardized for consistency and clarity.

This work begins in the field by sampling the chert from each stratigraphic member discussed in the first section of this paper. Maps and reports from the Kansas State Geological Survey and the

United States Geological Survey record locations of these exposures. A collection of known chert samples can then be used for experiments in characterization based on the discussion in section three. Resulting type definitions should be tested for accuracy and replicability. Quantitative means should be used to define the range of variation within each type and the amount of overlap between types. This portion of the study will not only provide data for characterization but will also establish a comparative collection of samples. Heat treatment experiments will provide information about physical and chemical alterations which can be expected in different types.

Established chert types will then be compared with chert artifacts found in archeological sites in the project area. This will accomplish two purposes: (1) to test the usefulness of the chert types; and, (2) to provide a tool for analysis of chert utilization. Establishing chert types can also aid in isolating nonlocal cherts, and unusual treatment of local material. The information which can be obtained in a study such as this will allow the questions concerning the prehistoric utilization of chert resources in the southern Flint Hills to be more thoroughly examined.

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